

Arizona Game and Fish Department
Grand Canyon Monitoring and Research Center Project
Mainstem Colorado River Fish Monitoring
1996 Annual Report

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EXECUTIVE SUMMARY

The 1996 field season of the Arizona Game and Fish Department (AGFD) Colorado River Fish Monitoring Project for Glen Canyon Environmental Studies included four river trips from Lees Ferry to Diamond Creek [28 February - 14 March (Trip 96-1), 18 April - 3 May (Trip 96-3), 19 June - 4 July (Trip 96-4) and 8 - 23 September (Trip 96-5)] and was punctuated by the occurrence of an Experimental Beach/Habitat-Building Flood (experimental flood) from 22 March - 7 April. A number of different methods and protocols were used. Types of data and samples collected include: habitat data, sediments, benthic invertebrates (benthos), zooplankton, parasites and fish.

Backwater Number

Backwater number decreased from 68 backwaters during Trip 96-1 to 39 on Trip 96-5, probably due to the experimental flood and abnormally high summer discharge. The effect of the experimental flood on backwaters varied: some were created, others reworked and still others destroyed. However many sandbars had very steep sides which eroded very quickly, destroying many backwater created by the flood.

Habitat Variables

Temperatures varied seasonally and increased with distance downstream from Glen Canyon Dam, similarly to that seen previously and mean backwater temperature was always higher than mean mainchannel temperature. Spring temperatures (Trips 96-1 and 96-3) were cool, with means of 10.74°C and 11.77°C (range: 9.3 - 15.5°C), respectively, in the mainchannel and 11.12°C and 12.42°C (range: 6.4 - 21.0°C), respectively, in backwaters. Mean temperatures increased during Trip 96-4 to 15.43°C and 13.08°C in backwaters and the mainchannel, respectively. Mean backwater (14.36°) and mainchannel (13.29°C) temperatures during Trip 96-5 were similar to Trip 96-4. Temperatures rarely exceeded 20°C, which was achieved only in backwaters.

Turbidity in the Colorado River rarely exceeded 30 NTU in 1996. The notable exception to this was during Trip 96-5 when monsoonal rains caused the LCR to discharge sediment-laden water (>25,000 NTU) into the Colorado River. On this trip, turbidity in the mainchannel and backwaters, above the LCR, reached only 11.0 NTU, while below the LCR, turbidity ranged from 15 - 6872 NTU.

Temperature and turbidity varied seasonally in each tributary (Appendices 9 - 10). Shinumo Creek was the coolest (10.5°C) on Trip 96-1 and LCR was the warmest (25°C) on Trip 96-4. Because of a drought in the southwestern United States in 1996, tributary discharges remained near base level throughout most of the year, causing turbidity to be generally low, ranging from 5.8 - 4.1 NTU with one exception. The LCR was flowing above base level on Trip 96-5 due to monsoonal rains when turbidity ranged from 6,500 - 25,750 NTU.

Sediment

Mean percentage of sand in backwater sediments ranged from 67.8 % during Trip 96-1 to 84.6 % during Trip 96-3 and mean percentage of silt ranged from 30.8 % during Trip 96-1 to 20.6 % during Trip 96-4. Organic matter comprised a small fraction of the sediment contents, never exceeding 1.2%. Mean percentage of CPOM ranged from 0.1% during Trip 96-3 to 0.4% during Trip 96-5. Mean percentage of FPOM ranged from 0.6 - 0.9% on Trips 96-3 and 96-1, respectively. There were no significant changes in the mean percentages of sand, silt or FPOM ($P \geq 0.1045$) in Colorado River backwaters during 1996. However, mean CPOM did vary among trips ($P=0.0079$) and was significantly lower during Trip 96-3 than all other trips.

Zooplankton

Total mean zooplankton density increased between Trips 96-1 and 96-3 from 2205.6/m³ to 4413.7/m³ decreased to 1300/m³ by Trip 96-5. Mean copepod density increased from 349.3/m³ during Trip 96-1 to 798.0/m³ during Trip 96-3 and did not change significantly until Trip 96-5 (116.7/m³). Mean copepod nauplii densities increased from 569.0/m³ during Trip 96-1 to 2177.8/m³ during Trip 96-3, decreased to 1308.3/m³ during Trip 96-4 and decreased further to 72.2/m³ by Trip 96-5. Mean rotifer density did not change between Trips 96-1 and 96-3, increased to 3716.7/m³ during Trip 96-4, but decreased to 1083.3/m³ by Trip 96-5. Mean branchiopod density did not vary significantly in 1996 (47.6/m³).

Mean zooplankton density also differed among reaches. During Trips 96-1 and 96-4, mean zooplankton density decreased in a linear fashion with distance downstream from Lees Ferry. During Trip 96-3, however, their distribution followed a higher order equation in which losses between RM 65.25 and RM 117.40 were minimal or nil. Zooplankton longitudinal distribution during Trip 96-5 did not change longitudinally.

While densities of Chironomidae, other dipterans and miscellaneous invertebrates varied among sampling periods, no differences in mean total invertebrate density were detected. Densities of Chironomidae and miscellaneous dipterans declined between Trips 96-1 and 96-3, but their densities rebounded to pre-flood levels by Trip 96-4. Densities of miscellaneous invertebrates were greater than Trip 96-1 during Trip 96-4 due to the presence of unidentified annelid worms. Total benthic invertebrate density varied by sampling location on Trip 96-1, but not on subsequent trips.

Benthic Invertebrates

Mean total AFDW invertebrate biomass did not vary among the four sampling trips. Mean biomass of Chironomidae and miscellaneous dipterans varied throughout 1996, decreasing between Trips 96-1 and 96-3, but attaining pre-flood levels by Trip 96-4. Biomass of miscellaneous invertebrates (primarily unidentified annelid worms) increased on Trip 96-3. Mean detrital biomass was highest during Trips 96-1 and 96-3 but declined during Trip 96-4.

Fish Collection Effort

A total of 135 seining samples in backwater sites covered 18,448 m², and an additional 33 mainchannel sites totaled 5,893 m² of effort. One hundred thirty-one electrofishing samples were conducted in the mainchannel, for a total of 150,339 seconds of effort. One hundred twenty-nine mainchannel trammel net sets totaled 268.31 hours of effort. Minnow traps were the only gear to be used in all three habitat types, although sparingly in backwaters (three sites for 52.46 hours). In the mainchannel, 171 groups of minnow traps were set for a total of 4402.3 hours. Thirty-one groups of minnow traps were set at tributary sites for a total of 479.08 hours. Hoop nets were set in tributaries for a total of 860.67 hours in 40 sets.

Fish Abundance

Catch-per-unit-effort varied among trips with changes in capture susceptibility and changes in numbers. Seasonal patterns of abundance were related to spawning migrations and the appearance of young-of-the-year (YOY) fish. Additionally, the experimental flood affected abundance of some non-native species, but their recovery was rapid.

Bluehead sucker (*Catostomus discobolus*) catches were low during Trips 96-1 and 96-3 except for adults in tributary mouths. Backwater seining catch increased to 12.7 / 100 m² during Trip 96-4 with the appearance of YOY's and hoop net catches decreased to 0.4 fish / 12 hours with the end of the spawning season. During Trip 96-5, bluehead sucker catches increased in minnow traps (0.05 fish / 24 hours), but decreased in backwaters (2.7 / 100 m²), as the juveniles became large enough to withstand the mainchannel and had begun to develop their cartilaginous scraper for feeding on rocky substrates.

Flannelmouth sucker (*C. latipinnis*) catches were high in both hoop nets set in tributary mouths (8.5 fish / 12 hours) and in trammel nets (47.2 fish / 100 hours) during Trip 96-1. During Trip 96-3, hoop net catches increased to 57.9 fish / 12 hours while trammel net catches decreased to 1.3 fish / 100 hours. Hoop net catches were lower during Trip 96-4 with the end of the spawning season. However, seining catch rate increased dramatically from <0.5 fish / 100 m² seined to 10.1 / 100 m² with the dispersal of YOY suckers from spawning tributaries into backwaters. During Trip 96-5, adult hoop net catches declined further (1.4 / 12 hours) but trammel net catches increased to 8.5 fish / 100 hours. Backwater seining catches also decreased.

Catches of adult humpback chub (*Gila cypha*) were high (~24 fish / 100 hours) in trammel nets during Trips 96-1 and 96-3. Electrofishing catches of juveniles remained relatively steady throughout the field season. Trammel net catches decreased to 3.9 fish / 100 hours during Trip 96-4 while catches of YOY humpback chub in backwaters increased to 2.8 / 100 m² as fish dispersed from the LCR. During Trip 96-5, backwater seining catch nearly doubled (4.7 / 100 m²) and minnow trap catches tripled (0.25 fish / 24 hours) as monsoon spates dispersed YOY humpback chub from the LCR. Catches of adults in trammel nets also increased to 16.8 fish / 100 hours during this trip.

Speckled dace (*Rhinichthys osculus*) catches were low in all gears during Trips 96-1 and

96-3. However, catch rates for speckled dace increased dramatically from <2.5 fish / 100 m^2 to $58.2 / 100\text{ m}^2$ in backwaters and decreased from approximately 0.23 fish / 10 minutes to $0.09 / 10$ minutes in electrofishing during Trip 96-4 as the backwaters warmed to temperatures greater than that of the mainchannel. Seine catches decreased during Trip 96-5 to $8.2 / 100\text{ m}^2$.

Fathead minnow (*Pimephales promelas*) abundance was affected by the experimental flood, with decreases in catch between Trips 96-1 and 96-3 in both backwater seining and by electrofishing. However, this species rebounded quickly by Trip 96-4, likely from tributary refugia and reproduction in backwaters. During Trip 96-5, backwater seining catch decreased but remained higher than before the flood.

Plains killifish (*Fundulus zebrinus*) were also affected by the flood: mean CPUE in backwaters decreased from 0.9 fish/ 100 m^2 seined (43 fish) before the flood to 0 fish/ 100 m^2 afterwards. A few plains killifish were captured in backwaters during Trip 96-4, but catches during Trip 96-5 reached 2.1 fish / 100 m^2 , exceeding all previous catches in 1996.

During Trips 96-1 and 96-3, no red shiner (*Cyprinella lutrensis*) were caught. However, during Trip 96-4 red shiner were caught at rates of $2.4 / 100\text{ m}^2$ seined in backwaters and 0.45 fish / 12 hours in hoop nets from the LCR. On Trip 96-5 more fish were caught (74) but the capture rate diminished to $1.6 / 100\text{ m}^2$ seined.

Rainbow trout (*Oncorhynchus mykiss*) appear to have been dispersed downstream by the flood, since they were commonly captured in downstream areas where they had previously been rare. During Trip 96-1 rainbow trout were commonly captured in trammel nets and by electrofishing but were rarely captured in backwaters. Following the flood (Trip 96-3) catch rates in trammel nets increased to 38.6 fish / 100 hours but electrofishing decreased to $1.7 / 10$ minutes. However, catches of rainbow trout in backwaters increased to 0.4 fish / 100 m^2 and remained high throughout the field season. Catches of rainbow trout by electrofishing increased through the summer to 3.6 fish / 10 minutes by Trip 96-5. Trammel net catches decreased on Trip 96-4 (9.7 fish / 100 hours) but increased dramatically to 66.9 fish / 100 hours during Trip 96-5.

Species Composition

Species composition in the mainstem Colorado River varies among reaches because of water quality changes and the presence of spawning areas or tributaries along the length of the Colorado River in Grand Canyon. As in previous years, fishes were more common in the vicinity of known or suspected spawning sites, particularly tributaries. Additionally, some non-native species [i.e., plains killifish and green sunfish (*Lepomis cyanellus*)] remain closely linked to the tributary from which they appear to have invaded Grand Canyon.

Reach 1 was sampled very little during 1996 and only three fish (0.04% of the total catch) of two species were captured. Two speckled dace and one rainbow trout were the only fish caught.

The LCR is the lower boundary of Reach 2 and the number of species found increased to seven. A total of 498 fish was captured, comprising 7.3% of all of the fish caught in 1996.

Rainbow trout were dominant (32.7%) and speckled dace remained common (9.8%). However, flannemouth sucker (28.3%) and humpback chub (8.2%) also became common. Non-native fathead minnow (17.7%), plains killifish (2.6%) and common carp (0.6%) populated the lower portions of Reach 2, probably having moved upstream from the LCR.

Reach 3 is situated immediately below the LCR, which is the spawning site for at least ten species of native and non-native fishes. This area was sampled intensively and 1,156 fish were caught, comprising 16.9% of the fish captured. Fathead minnow dominated, comprising 26.7% of the total number of fish caught. However, all four remaining native species were well represented with speckled dace comprising 22.9%, humpback chub 19.5%, bluehead sucker 7.7% and flannemouth sucker 4.2% of the total catch. Rainbow trout were still common (15.0%) with plains killifish (2.2%), common carp (0.9%), red shiner (0.7%) and brown trout (*Salmo trutta*; 0.3%) also present.

Sampling in Reach 4 captured 1,599 fish (23.4%). Fathead minnow became more dominant, comprising 61.0% of the total catch. Humpback chub were still common (15.8%) and speckled dace (4.4%), bluehead sucker (1.4%) and flannemouth sucker (1.0%) were also still captured. Plains killifish (4.9%) increased in relative abundance and common carp, brown trout and red shiner each comprised <1% of the total catch.

Reach 5 was sampled regularly only near Shinumo Creek and opportunistically at some other sites. Only 89 fish were captured in this reach, comprising 1.3% of the total catch. Fathead minnow dominated the fish fauna, comprising 39.3% of the catch. Speckled dace (21.3%), flannemouth sucker (14.6%) and rainbow trout (13.5%) are the remaining common species. Humpback chub (6.7%) were also found here along with bluehead sucker (2.2%), common carp and brown trout (1.1%, each).

A total of 331 fish (4.9%) were captured in Reach 6. Fathead minnow remained the dominant species, comprising 53.5% of the fishes captured. Speckled dace (18.1%) and humpback chub (11.8%) were also commonly captured. Bluehead sucker (6.3%) and flannemouth sucker (5.1%) were also found in this reach, as were rainbow trout (2.4%), plains killifish (1.5%) and red shiner (1.2%).

Reach 7 includes the confluences of Kanab and Havasu creeks, two important spawning streams for bluehead and flannemouth suckers. A total of 1557 fish were captured in this reach, comprising 22.8% of the total 1996 catch. Fathead minnow remained the dominant species, comprising 56.6% of the fish caught. Flannemouth sucker (17.6%), speckled dace (13.7%) and bluehead sucker (7.9%) were also commonly captured. A large number of other species were incidentally captured in this reach, including: rainbow trout (2.1%) and common carp, plains killifish, humpback chub, red shiner, brown trout, green sunfish and yellow bullhead (*A. natalis*), which comprised <1% each.

A total of 1,588 fish, comprising 23.3% of all fish captured in 1996, were captured in Reach 8. Speckled dace became the dominant species in this reach, comprising 58.4% of the total catch. Fathead minnow (27.0%), flannemouth sucker (9.6%) and bluehead sucker (3.8%) were

also common, while common carp, plains killifish, red shiner and green sunfish each comprised <1% of the total number caught.

A total of 1,051 fish was captured in the Little Colorado River (LCR) during Colorado River trips in 1996. Fathead minnow was the most common species captured, comprising 70.9% of the total number of fish. Other species commonly captured included bluehead sucker (6.1%), plains killifish (5.6%), flannemouth sucker (5.4%), humpback chub (4.5%), common carp (4.5%) and red shiner (2.1%). Channel catfish (*Ictalurus punctatus*), rainbow trout and speckled dace comprised <1%, each.

Sampling in Shinumo Creek yielded 233 fish. Fathead minnow (44.6%) and speckled dace (30.0%) were the most commonly captured species. Bluehead sucker (12.0%) and flannemouth sucker (10.3%) were also common and humpback chub (1.7%) and rainbow trout (1.3%) were also present.

We captured 628 fish in Kanab Creek and fathead minnow (53.5%) was the most common species. Flannemouth sucker (29.6%), speckled dace (8.8%) and bluehead sucker (4.9%) were also common. Green sunfish (1.9%), rainbow trout (0.8%), plains killifish (0.3%) and common carp (0.2%) were also captured.

A total of 327 fish was captured in Havasu Creek in 1996. Flannemouth sucker (68.8%) was most common, with speckled dace (26.3%) and bluehead sucker (3.7%) also being common. Two humpback chub (0.6%) and one (0.3%) each of fathead minnow and rainbow trout were also captured in the mouth of Havasu Creek.

Species Distribution

Distribution of native fishes in Grand Canyon is linked to known or suspected spawning tributaries and non-native fish distributions are also linked to warm tributaries. Some non-native species have not extensively expanded their ranges in Grand Canyon and are still most common in the tributary through which they probably invaded, while other non-native fishes are more widespread in Grand Canyon.

Bluehead sucker was captured in all reaches below the LCR (Reaches 3 - 8). This species comprised from 7.9% of the catch in Reach 7 and 7.7% of the catch in Reach 3 to 1.4% in Reach 4. Bluehead sucker were also captured in all four tributaries sampled. They comprised as little as 3.7% of the catch in Havasu Creek and as much as 12% of the catch in Shinumo Creek.

Flannemouth sucker was found in all mainstem reaches, except Reach 1, where little effort was expended. Flannemouth sucker comprised 28.3% of the catch in Reach 2 where they are suspected of spawning in warm springs below RM 30. They were also commonly captured in Reaches 7, 5 and 8 where they comprised 17.6%, 14.6% and 9.6% of the catches, respectively. Flannemouth sucker was also caught in all four sampled tributaries. They were most commonly captured in Havasu Creek, where they comprised 68.8% of the catch, but were also common in Kanab and Shinumo (10.3%) creeks. Flannemouth sucker comprised only 5.4% of the catch in the LCR.

Humpback chub were captured in Reaches 2 - 7. They were most common in Reaches 3 and 4, where they comprised 19.5% and 15.8% of the catches, respectively. Humpback chub also comprised 11.8% of the catch in Reach 6. Humpback chub were also captured in three of the four sampled tributaries. They comprised 4.5% (47 fish) of the catch in the LCR, 1.7% (4 fish) in Shinumo Creek and 0.6% (2 fish) in Havasu Creek.

Speckled dace were common throughout Grand Canyon. Their prevalence ranged from 66.7% in Reach 1 and 58.4% in Reach 8 to 4.4% in Reach 4. Speckled dace were also captured in all four sampled tributaries, where they comprised from 30.0% in Shinumo Creek to 0.1% in the LCR.

Common carp were found in all reaches, except Reaches 1 and 6. They were not commonly caught in any reach, comprising <1% of the total catch in only Reach 5. As many as 11 fish were caught in Reach 8 where they comprised 0.7% of the catch. Common carp were also found in the LCR (4.5%) and Kanab Creek (0.2%).

Fathead minnow was caught in all reaches, except Reach 1 and was the most common species captured, overall. They comprised 45.1% of the total catch and $\geq 17.7\%$ of the catch in all reaches, exceeding 50% of the catch in Reaches 4, 6 and 7. Fathead minnow was also caught in all sampled tributaries. Only one fish (0.3%) was caught in Havasu Creek. However, they comprised 70.9% of the catch in the LCR, 53.5% in Kanab Creek and 44.6% in Shinumo Creek.

Red shiner was captured in Reaches 3, 4, 6, 7, and 8. They were not common in any reach, however, with their prevalence ranging from 0.1% in Reach 8 to 1.2% in Reach 6. The only tributary in which red shiners were caught was the LCR, where they comprised 2.1% of the total catch.

Plains killifish were found in all reaches, except Reaches 1 and 5. They were most commonly captured in Reach 4, where they comprised 4.9% of the total catch. In Reaches 7 and 8, they comprised only 0.5% and 0.4% of the total catch. Plains killifish were also found in the LCR and Kanab Creek, where they comprised 5.6% and (0.3%), respectively.

Rainbow trout were captured in all reaches, except Reach 8. They were most common above the LCR, where they comprised 33.3% and 32.7% of the catches in Reaches 1 and 2, respectively. Below the LCR, their prevalence ranged from 13.5% in Reach 5 to 2.1% in Reach 7. Rainbow trout were also caught in all sampled tributaries, but in low numbers. As few as one fish was caught in the LCR (0.1%) and Havasu Creek (0.3%) and as many as five fish (0.8%) were caught in Kanab Creek. Rainbow trout comprised 1.3% (3 fish) of the total catch in Shinumo Creek.

Brown trout were caught in Reaches 3, 4, 5 and 7. They were uncommon in all areas and were not caught in any of the tributaries. They comprised from 1.1% of the catch in Reach 5 to 0.1% in Reach 7. As many as six fish (0.4%) were caught in Reach 4.

Channel catfish were captured only in the LCR. They comprised 0.8% of the total catch in that tributary.

Green sunfish were found in Kanab Creek and in Reaches 7 and 8. Only three fish (0.1% of the catch in each reach) were captured in the mainstem, while 12 fish (1.9%) were caught in

Kanab Creek.

Three other rare fishes were captured during 1996. The most interesting catch may have been that of a flannelmouth sucker x razorback sucker (*Xyrauchen texanus*) hybrid captured in the LCR side channel during the experimental flood. The other unusual capture was that of a redbreasted shiner (*Richardsonius balteatus*), captured at RM 63.70 during the experimental flood. One yellow bullhead was also captured, comprising 0.1% of the catch, in Reach 7.

Length Frequency Analyses

Young-of-the-year and adults of all native species were collected. However, sub-adult bluehead sucker, flannelmouth sucker and humpback chub were rarely collected, lending concern for recruitment into the adult populations of these species. All life history stages of all commonly captured non-native species were present.

Age 1 bluehead suckers (20 - 69 mm) were common in the catch along with adults (180 - 309 mm) on Trip 96-1. Fewer bluehead suckers were captured on Trip 96-3, with sizes ranging from 20 - 369 mm. Young-of-the-year appeared on Trip 96-4, after drifting out of spawning tributaries as 10 - 39 mm fish and age 1 fish continued to be captured (30 - 89 mm). On Trip 96-5, the majority of fish ranged from 20 - 109 mm (YOY and age 1 fish) with a few sub-adults (140 - 159 mm) and adults (190 - 339 mm).

Two groups of flannelmouth sucker were captured on Trip 96-1: 20 - 129 mm fish (comprising age 1 and probably some age 2 fish) and 290 - 589 mm fish (spawning adults). On Trip 96-3 nearly all fish captured were adults or sub-adults (170 - 529 mm) in spawning tributaries - only ten other fish were captured (20 - 109 mm). Conversely, on Trip 96-4, nearly all flannelmouth suckers caught were YOY and age 1 fish (10 - 89 mm). By Trip 96-5, YOY and age 1 fish (10 - 129 mm) still dominated the catch, but fewer numbers were caught. Sub-adults and adults were also caught, up to 579 mm.

On Trips 96-1 and 96-3, age 1 (20 - 119 mm) and adult (310 - 469 mm) humpback chub were most commonly captured. On Trip 96-4, though, age 1 fish (20 - 159 mm), possibly with some YOY's and age 2 fish dominated the catch, with only six larger fish being captured. On Trip 96-5 large numbers of YOY and age 1 (30 - 149 mm) humpback chub were caught.

On Trip 96-1, age 1 fish dominated the catch with a modal length class of 3 cm and by Trip 96-3, these fish had increased in size to a modal length class of 4 cm. On Trip 96-4, YOY dominated the catch, ranging from 10 - 39 mm. Age 1 fish (modal length class=5 cm) were captured in numbers similar to the previous trips. On Trip 96-5, fewer age 1 fish were caught and the YOY's had reached a modal length class of 4 cm.

Common carp were caught infrequently on Trip 96-1. Ten carp were captured ranging from 70 - 159 mm and another five ranged from 410 - 579 mm. Only seven carp (300 - 649 mm) were caught on Trip 96-3. Probable age 1 carp (20 - 79 mm) were the dominant group caught on Trip 96-4, with nine other fish (180 - 669 mm) also being caught. Only eleven common carp (50 - 229 mm) were captured on Trip 96-5.

Fathead minnow were commonly caught on Trips 96-1 and 96-3, with most being age 1 fish (modal length class = 4 cm). On Trip 96-4, similar numbers of age 1 fish (modal length class = 5 cm) were caught, but YOY (modal length class = 2 cm) appeared in large numbers. By Trip 96-5 the YOY had grown, with a modal length class of 4 - 5 cm.

On Trip 96-1, 49 plains killifish were caught, ranging in size from 20 - 79 mm and with a modal length class of 3 cm. The experimental flood decimated their numbers and none were captured on Trip 96-3. By Trip 96-4, 51 YOY (10 - 39 mm) and one adult were captured. On Trip 96-5, the YOY had reached a modal length class of 3 cm and we observed and captured large numbers of plains killifish in backwaters.

Subadult and adult rainbow trout (160 - 479 mm) were commonly captured on Trip 96-1 with only three other fish (20 - 49 mm) being caught. After the experimental flood (Trip 96-3), similar numbers of subadults and adults (210 - 439 mm) were captured, but nearly 50 YOY (20 - 79 mm) were caught. On Trip 96-4, adults (250 - 429 mm) remained common, while fewer YOY (now 30 - 119 mm) were caught. By Trip 96-5, adults (270 - 449 mm) remained common and the YOY had grown considerably (modal length class = 20 cm).

Red shiner were not captured until Trip 96-4, when 10 age 1 fish (36 - 52 mm) were captured. On Trip 96-5 an additional 33 red shiner, including some YOY, were caught, ranging in length from 22 - 66 mm.

PIT Tagging

Forty-eight bluehead suckers (153 - 344 mm) were captured, none of which had been previously implanted (recapture) with a PIT tag. A total of 520 flannemouth suckers was caught (173 - 582 mm). We marked 441 (84.8%) flannemouth suckers and 79 (15.2%) were recaptured. Ninety-nine humpback chub (150 - 460 mm) were caught: 27 (27.2%) marks and 72 (72.8%) recaptured. One coded-wire tagged rainbow trout (335 mm) was captured.

Flannemouth suckers were at-large for a mean of 692 days (0 - 1730 days) and gained a mean of 105.8 mm TL (-8 - 338 mm) and 344.9 g (-37 - 877g). These fish grew at a mean rate of 4.8 mm and 14.1g / 30 days. Mean distance between capture sites was 40.2 river miles and ranged from 0 - 161.65.

Recaptured humpback chub were at-large for a mean of 1363 days (0 - 2190 days). They gained a mean of 24.0 mm TL (-8 - 200 mm) and 103.7 g (-74 - 418 g), rates of 0.47 mm and 2.63 g / 30 days. Mean distance between capture sites was 2.04 miles (0 - 29.82).

Humpback Chub Health

Juvenile chub sampled in the mainstem Colorado River were longer, heavier and had a greater mean condition factor than those from the LCR, indicating increased health. This difference in weight and K was evidenced by a greater amount of mesenteric fat in the mainstem fish. Juvenile humpback chub from the LCR were also more likely to be infected by the two species of parasites monitored in this study. Only 8.8% and 5.9% of the Colorado River fish were

infected by *B. acheilognathi* and *Lernaea cyprinacea*, respectively, while 38.1% and 47.6% of the LCR fish were infected. The rate of *Lernaea* infestation was also higher in the LCR, with a mean of 0.905 *Lernaea* / fish, but only 0.059 *Lernaea* / fish in the mainstem.

Asian Fish Tapeworm

Four species of fish were found to be infected by the Asian fish tapeworm. Forty percent of humpback chub, 7.3% of fathead minnow, 2.4% of plains killifish and 1.2% of speckled dace were infected while no sampled bluehead sucker, flannelmouth sucker or red shiner were infected. The infestation rate for humpback chub was 0.74 tapeworms / fish, 1.86 tapeworms / infected fish and a maximum infestation of four tapeworms. Infestation rates for all other species was <0.08 tapeworms/fish.

Fish infected with the Asian fish tapeworm were collected only in the LCR and in Reaches 3 and 4. In the LCR, 78.6% of the sampled humpback chub and 6.8% of the fathead minnow were infected. In the mainchannel, infestation rates ranged from 15% in humpback chub in Reach 3 to 7.7% of plains killifish in Reach 4.

Green Sunfish Diet

Adult green sunfish (155-196 mm TL) GI tracts primarily contained snails (Gastropoda) and aquatic insects (Hemiptera, Trichoptera and Odonata), although terrestrial insects (primarily Coleoptera) were also common. These green sunfish in Kanab Creek were also piscivorous, as two (12.5%) GI tracts contained remains of speckled dace (40 and 46 mm TL).

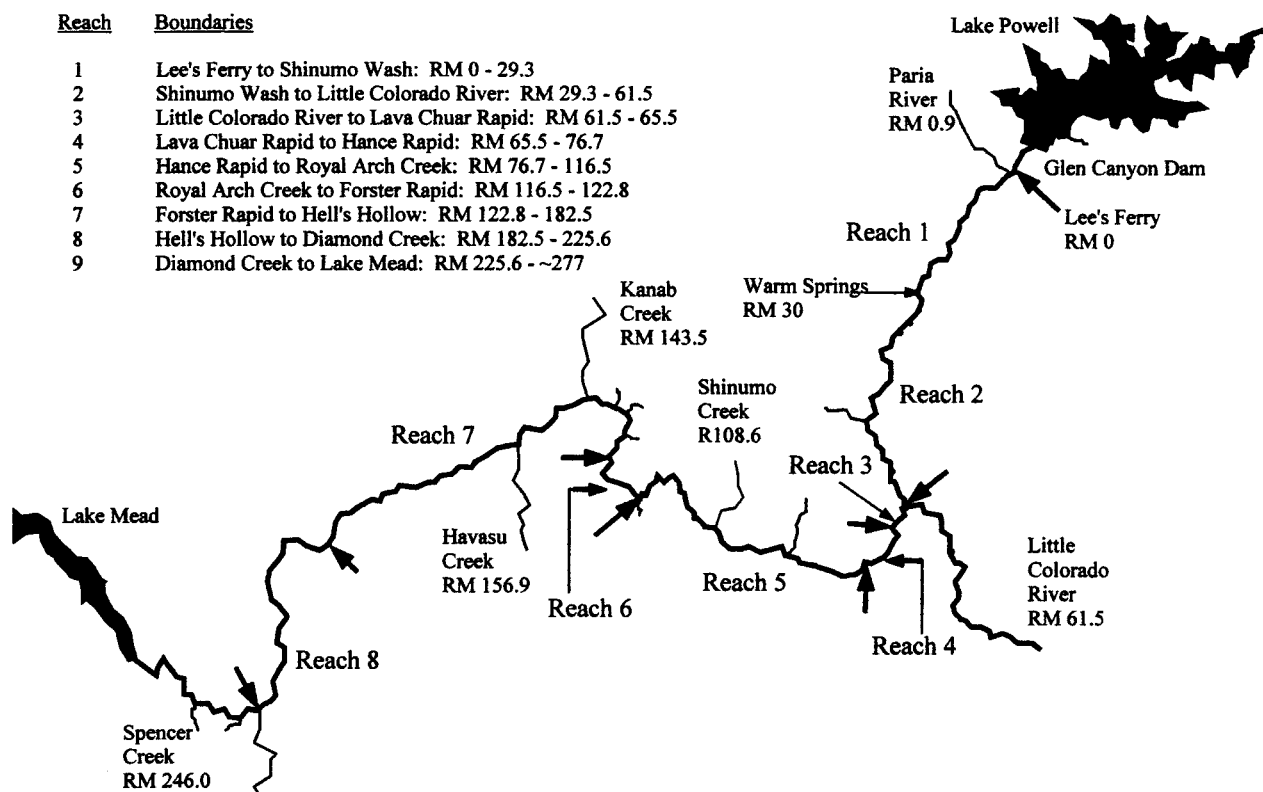


Figure 1. Tributaries of the Colorado River, Grand Canyon, Arizona and sampling reaches used by AGFD during 1996 fish monitoring. Arrows denote reach boundaries.

INTRODUCTION

The 1996 field season of the Arizona Game and Fish Department (AGFD) Colorado River Fish Monitoring Project for Glen Canyon Environmental Studies included four river trips from Lees Ferry (RM¹ 0) to Diamond Creek (RM 225.6): 28 February - 14 March (Trip 96-1), 18 April - 3 May (Trip 96-3), 19 June - 4 July (Trip 96-4) and 8 - 23 September (Trip 96-5). Sampling on each of these trips was designed to target specific fish species and size classes vulnerable to capture during each period. On each of the monitoring trips, AGFD was responsible for monitoring fishes in the mainstem Colorado River from Lees Ferry to National Canyon (RM 166.4) and its major tributaries: the Paria and Little Colorado rivers and Shinumo, Kanab and Havasu creeks (Figure 1). Monitoring from National Canyon to Diamond Creek (RM 225.6), was conducted jointly with the Hualapai Department of Natural Resources (HDNR). In this reach, HDNR was responsible for sampling the mainchannel Colorado River

¹ Note: locations in the mainstem Colorado River are denoted as river miles (RM) downstream from Lees Ferry (RM 0). Additionally, sampling sites are given the notation of "L" or "R" for left or right, respectively, side of the river when facing downstream.

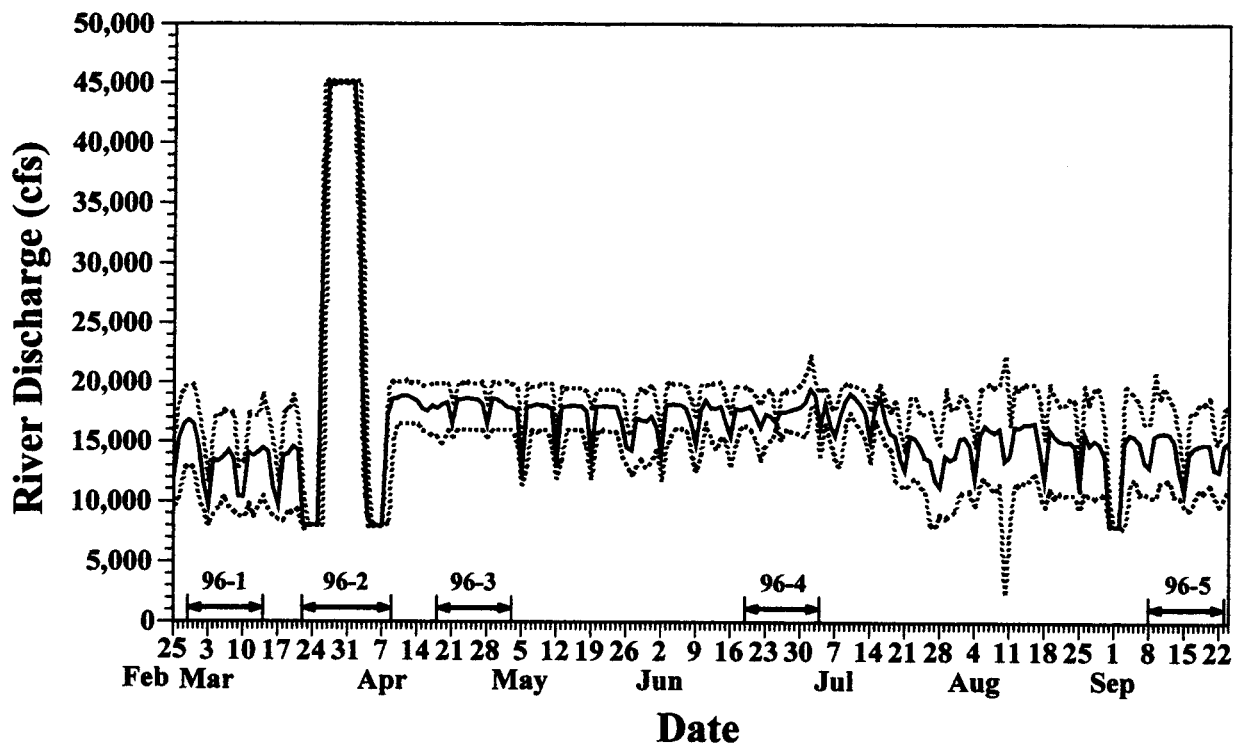


Figure 2. Mean, minimum and maximum daily discharges from Glen Canyon Dam, Arizona, 25 February - 24 September 1996.

(and will report their data independently) while AGFD was responsible only for sampling backwaters. Appendix 1 lists all sample sites on each fish monitoring trip in 1996. Appendix 2 provides a list of codes used by AGFD. Sampling was also conducted in the Little Colorado River (LCR) and Paria River during 1996 and these data are reported in Brouder and Hoffnagle (1997a; b).

The 1996 field season was punctuated by the occurrence of an Experimental Beach/Habitat-Building Flood (experimental flood) from 22 March - 7 April (Figure 2) which was "designed to rebuild high elevation sandbars, deposit nutrients, restore backwater channels, and provide some of the dynamics of a natural system" (U.S. Department of the Interior 1995). This annual monitoring report contains some data collected as part of this experiment, but does not address the effects of the experimental flood on the fishes, aquatic biota or their habitat. Data from Trip 96-2 (22 March - 9 April), which took place during the experimental flood, has not been included in this report due to the experimental nature of the sampling and the limited area sampled. For a discussion of the effects of the experimental flood on the aquatic biota and their habitats see AGFD (1996a) and subsequent publications: Brouder et al. (*In review*), Hoffnagle et al. (*In review*), Valdez and Hoffnagle (*In review*), Valdez et al. (*In review*) and reports by other agencies and researchers (e.g., Webb et al. *In review*).

STUDY AREA

The study area is the Colorado River in Grand Canyon from Lees Ferry to Diamond Creek in Grand Canyon National Park, Arizona (Figure 1). Additionally, the lowermost portions of four major tributaries were sampled. These tributaries are important spawning areas for native fishes (AGFD 1996b) and include: LCR (RM 61.5), Shinumo Creek (RM 108.6), Kanab Creek (RM 143.5) and Havasu Creek (RM 156.9).

METHODS

A number of different methods and protocols were used. Types of data and samples collected include: habitat data, sediments, benthic invertebrates (benthos), zooplankton, parasites and fish. Fish were collected using seines in backwaters and adjacent mainchannel beachfaces, trammel nets and electrofishing in the mainchannel, minnow traps in the mainstem Colorado River and tributaries and hoop nets in tributaries. Each of these gears was used as part of a specific sampling protocol, which are described in detail below. At all sites, a unique study number was assigned and site location, date, time, estimated river discharge and flow stage were recorded along with codes characterizing the type of sample, gear type used and type of habitat sampled (Appendix 2).

Backwaters

Backwaters are important rearing areas for native fishes (Holden 1978; Valdez and Clemmer 1982; Carter et al. 1985; Maddux et al. 1987; Minckley 1991; Angradi et al. 1992; AGFD 1996b) and were sampled using one of two protocols: Type A sampling or Type O sampling. Type A samples are designed to provide a detailed characterization of the backwater habitat and its fish, invertebrates and sediments. Type O samples are less intensive, providing only fish and water quality information.

Backwater Counts

Additionally, the total number of backwaters from Lees Ferry to Diamond Creek was counted as we moved downstream during each trip. Backwater location (river mile and side of river), date, time and estimated river discharge were all recorded.

Type O Sampling

The first step in a Type O sample was to block off the backwater, to prevent escape of fish, using the bag seine (15.2 m x 2 m x 3.2 mm mesh) to be used for fish capture. Next, a water sample was collected from the middle of the site for measurement of turbidity. Other water quality measurements were then taken from the middle of the backwaters including temperature (°C), dissolved oxygen (DO; mg / L and percent saturation), specific conductance (conductivity; $\mu\text{S} / \text{cm}$), pH and redox potential (mV). Ambient light was also characterized. The backwater was

then seined and data collected from all fish captured (see Fish, below). Lastly, representative depth and velocity were measured and primary and secondary sediments were characterized in the middle of the backwater, and maximum depth of the backwater measured. Width and length of the backwater were estimated to estimate total area seined, which was used for calculation of catch-per-unit-effort (CPUE = number of fish caught / 100 m² seined).

Type A Sampling

Type A backwaters were also blocked off to prevent escape of fish as the first step, but with a straight seine (10 m x 2 m x 3.2 mm mesh wings and 1.6 mm mesh bag) used only for this purpose. The backwater was then divided into three sections: mouth (opening to mainchannel), center and foot. Turbidity measurements were then taken from the middle of each section, followed by collections of zooplankton samples (see Zooplankton, below) in the same locations. Subsequently, water quality measurements were made at three points, equidistant along a transect through the middle of each section. Temperature was recorded from each of the three transect points while DO, conductivity, pH and redox potential were recorded only from the center. Next, benthos and sediment samples were collected (see Benthic Invertebrates and Sediments, below) from the middle of each section. When this had been completed, at least three passes were made through the backwater with a bag seine (10 m x 2 m x 3.2 mm mesh wings and 1.6 mm mesh bag) to estimate the fish population by depletion (Bagenal 1978; Everhart and Youngs 1981). Data were collected from all fish captured (see Fish, below). When fish sampling was completed, the block net was removed so that velocity and depth could be accurately measured. Sediment was also characterized at the three transect points in each section of the backwater at this time. Lastly, maximum depth of the backwater was measured. Total station surveys were also conducted of the backwaters which provided total surface area and bathymetric contours of the site. Area seined for calculation of CPUE was obtained from these data.

Data were also collected in the mainchannel at Type A sites. The adjoining beach face was first seined. Next, water quality measurement were taken along a transect (as for backwaters) perpendicular from shore in the middle of the seined area. Zooplankton samples were collected from these same points. Length and width of the seined area were estimated for calculation of seining effort.

Mainchannel

Electrofishing, minnow traps and trammel nets were deployed to sample fish found in mainchannel habitats. Talus, debris fan and vegetated shorelines and eddies, areas in which seining was not practical, were sampled to capture the generally larger fish inhabiting these habitats.

Electrofishing

Electrofishing was used to capture fishes of all sizes along talus, debris fan and vegetated shorelines. Standardized sites used by Bio/West (Valdez and Ryel 1995) were sampled from the

LCR to Tanner Rapid (RM 68.5) and from RM 125.5 - 128. We designated additional sites in other areas of the river. Electrofishing was conducted from an Achilles sportboat and always employed two netters, to maximize efficiency (Valdez and Ryel 1995). Effort was recorded as the number of seconds of each run and CPUE was calculated as the number of fish caught / 10 minute electrofishing run.

Minnow Traps

Minnow traps, which are size-selective for small fish, were also deployed along talus, debris fan and vegetated shorelines. Each minnow trap set consisted of five minnow traps and were checked at least every 24 hours, although most sets were shorter (overnight). Set and run date and time were recorded for calculation of effort (hours). Catch-per-unit-effort was calculated as the number of fish caught / 24 hour set of five traps. Standardized sites used by Bio/West (Valdez and Ryel 1995) were sampled from the LCR to Tanner Rapid and from RM 125.5 - 128. Additional sites were delineated in other areas of the river.

Trammel Nets

Trammel nets targeted larger fishes and were set in eddies or other relatively low velocity areas. Trammel nets used were six feet (1.83 m) high by 50 (15.24 m) or 75 feet (22.61m) long with one inch (2.54 cm) or 1.5 inch (3.81 cm) inner panel mesh and 10 inch (25.4 cm) outer panel mesh. These nets were set at dusk for two 2 hour sets. Set and run times were recorded for calculation of effort (hours) and CPUE (= number of fish caught / 24 hour set). We tried to use the same standardized sets on each trip, but river discharge sometimes made sites unsuitable and alternative sites were found.

Tributaries

Five major tributaries were sampled, each an important spawning tributary for native fishes. Shinumo, Kanab and Havasu creeks were sampled on each trip, using a winged hoop net to capture fish entering the stream at night (particularly spawning adults) and minnow traps to capture smaller fishes in the lower reaches of the stream. The LCR was sampled only on Trips 96-4 and 96-5 using mini-hoop nets to capture small fishes. The Paria River (RM 0.9), being much more accessible, was sampled frequently throughout the year, particularly during the summer growing season. Paria River sampling was done in association with Michele Thieme (University of Arizona) but the data are not reported here. For detailed examination of these data, the reader is directed to Thieme (1998) and Brouder and Hoffnagle (1997b).

Hoop Net with Wings

A winged hoop net (1m diameter; 10 cm throat; 10 mm mesh) was deployed in the mouths of tributaries to capture fishes moving into that stream at night from the mainstem Colorado River and is particularly effective in spring and late summer to capture spawning flannelmouth sucker (*Catostomus latipinnis*) and bluehead sucker (*C. discobolus*; AGFD 1996b). Wings on this net

were stretched to each shore, blocking off the mouth of the tributary and guiding all fish entering the tributary into the net. Due to unusually high dam discharges, the top of the net and part or all of the float line of the wings was often submerged, making it possible for fish to escape by swimming over the net. However, due to the benthic nature of fishes targeted by this gear (suckers) we feel that fish seldom swam over the net since catches of these species were usually high and similar to previous years when water levels were lower. This net was set just before dusk and pulled in the early morning. Set and run times were recorded for calculation of effort (hours) and CPUE (= number of fish caught / 12 hour set).

Mini-hoop Nets

Mini-hoop nets (52 cm diameter; 10 cm throat; 5 mm mesh) were set in the LCR to capture small to medium sized fishes since the winged hoop net was not practical due to the large size of that tributary. As many as nine nets were set in the lower 500 m of this stream. Nets were checked approximately every 24 hours and CPUE was calculated as the number of fish caught / 24 hour set.

Minnow Traps

Minnow traps were set in low velocity habitats in the lower reaches of tributaries to capture small fishes, particularly young-of-the-year (YOY) native fishes spawned there. As in the mainstem, groups of five traps were set in the afternoon and pulled the next morning. Catch-per-unit-effort was calculated as the number of fish caught / 24 hour set of five traps.

Sample Collections

A number of different samples were collected with varying protocols. Sediment and benthos were collected only from backwaters. Zooplankton was collected from backwaters and the mainchannel. Fish were captured in all sampled habitats. Humpback chub (*Gila cypha*) were collected from the LCR and mainchannel below the LCR for assessment of fish health and monitoring of infection rate of the Asian fish tapeworm (*Bothriocephalus acheilognathi*; Cestoda) and the anchor worm (*Lernaea cyprinacea*; Copepoda). Speckled dace (*Rhinichthys osculus*), fathead minnow (*Pimephales promelas*) and plains killifish (*Fundulus zebrinus*) were collected throughout the Colorado River and tributaries in Grand Canyon to monitor distribution of *B. acheilognathi*. Lastly, green sunfish (*Lepomis cyanellus*) gastrointestinal tracts were collected from Kanab Creek for a cursory examination of the diet of this potential predator of larval and juvenile native fishes.

Sediment Samples

Backwater sediments are important to the fish community because they are habitat for benthic invertebrates, an important food source for native fishes (AGFD 1996b). A 50 mL sediment core was collected from the mouth, center and foot of each Type A backwater and

preserved in 70% ethanol or isopropanol. In the laboratory, the percentages of fine (<65 μm) and coarse (>65 μm) inorganic (silt and sand, respectively) and organic [fine particulate organic matter (FPOM) and coarse particulate organic matter (CPOM), respectively] particles were determined for each sample (see AGFD 1996a; b; Hoffnagle and Tuegel 1997).

Zooplankton

Zooplankton are an important food source for small fishes, including early life stages of native fishes, and their density varies seasonally, longitudinally and among habitats (AGFD 1996b). Zooplankton samples were collected from both the mainchannel and backwater at Type A sites by filtering 50 L of water through a #40 Wisconsin bucket net (80 μm mesh) and preserving them in 70% ethanol or isopropanol. In the lab, zooplankton were identified to the lowest practical taxonomic level, at least family and usually genus (Pennak 1978; Stemberger 1979; Thorpe and Covich 1991) and enumerated. For these analyses, zooplankton were pooled into the following taxa: Copepoda (copepodites and adults), copepod nauplii, Branchiopoda and Rotifera. Density of zooplankton was determined and extrapolated to number / m^3 (Hoffnagle and Tuegel 1997). Nonparametric tests were performed on total zooplankton density and density of major taxa using sampling trip (Kruskal-Wallis tests) and habitat (backwater vs. mainchannel; Mann-Whitney U tests) as main effects ($\alpha=0.05$ for all tests). Linear and curvilinear regression analyses were performed on square-root transformed total density estimates to detect longitudinal trends in zooplankton distribution. Finally, analysis of covariance was conducted on square-root transformed total zooplankton density using sampling date as a main effect and water temperature as a covariate.

Benthic Invertebrates

Benthic invertebrates are an important source of food for all sizes of native fishes in Grand Canyon (Valdez and Ryel 1995; AGFD 1996a; b). Three replicate samples from each backwater were collected with a petite Ponar dredge (0.0232 m^2) and filtered through a 600 μm mesh littoral bucket. All remaining detritus and organism were preserved in 70% ethanol or isopropanol. In the laboratory, organism were enumerated by the following taxonomic categories: Crustacea (Ostracoda and *Gammarus lacustris*), Chironomidae, other Diptera (Simuliidae and Ceratopogonidae), Mollusca (Gastropoda and Bivalvia), Nematoda, Oligochaeta, and miscellaneous invertebrates (unidentified Annelida, Cladocera, Trichoptera, Hemiptera, Hymenoptera, Ephemeroptera, and Odonata) using keys of Pennak (1989) and Merritt and Cummins (1984). Density was calculated and extrapolated to the number of organisms / m^2 . Organic matter and detritus were ashed (500°C for 2 hours) and biomass calculated and extrapolated to ash-free dry weight (AFDW; g) / m^2 (Hoffnagle and Tuegel 1997). Benthic invertebrate density and biomass were analyzed using Kruskal-Wallis tests followed by sequential Bonferroni tests.

Table 1. Common name, scientific name and family of native and non-native fishes captured during AGFD monitoring in the Colorado River and tributaries in Grand Canyon, 1996.

Common Name	Scientific Name	Family
<u>Native Species</u>		
Bluehead Sucker	<i>Catostomus discobolus</i>	Catostomidae
Flannelmouth Sucker	<i>Catostomus latipinnis</i>	Catostomidae
Flannelmouth Sucker x	<i>Catostomus latipinnis x</i>	
Razorback Sucker Hybrid	<i>Xyrauchen texanus</i>	Catostomidae
Humpback Chub	<i>Gila cypha</i>	Cyprinidae
Speckled Dace	<i>Rhinichthys osculus</i>	Cyprinidae
<u>Non-native Species</u>		
Green Sunfish	<i>Lepomis cyanellus</i>	Centrarchidae
Common Carp	<i>Cyprinus carpio</i>	Cyprinidae
Fathead Minnow	<i>Pimephales promelas</i>	Cyprinidae
Red Shiner	<i>Cyprinella lutrensis</i>	Cyprinidae
Redside Shiner	<i>Richardsonius balteatus</i>	Cyprinidae
Plains Killifish	<i>Fundulus zebrinus</i>	Cyprinodontidae
Channel Catfish	<i>Ictalurus punctatus</i>	Ictaluridae
Yellow Bullhead	<i>Ameiurus natalis</i>	Ictaluridae
Brown Trout	<i>Salmo trutta</i>	Salmonidae
Rainbow Trout	<i>Oncorhynchus mykiss</i>	Salmonidae

Fish

Fish collections were attempted from all habitats sampled. All fish were identified to species (Table 1) and total length (TL; mm) and weight (tenths of a gram) were recorded. Standard length (mm) was also measured and recorded for humpback chub. All humpback chub, bluehead sucker and flannelmouth sucker ≥ 150 mm TL were checked for the presence of a PIT tag and, if not present, one was implanted. All PIT tag numbers were recorded. All fish were released alive at the site of capture unless otherwise noted.

Humpback Chub Health

Juvenile (<120 mm TL) humpback chub were collected from the LCR and mainstem Colorado River below the LCR for health assessment (Goede and Barton 1990; Goede 1993) and

monitoring of *B. acheilognathi* and *Lernaea cyprinacea* which infect humpback chub more than any other fish in the system (Brouder and Hoffnagle 1997c; Clarkson et al. 1997; Hoffnagle et al. 1997). Necropsies were performed in the field and followed a protocol modified from Goede(1993). The number of *Lernaea* on each fish was also recorded followed by preservation of the fish in 90% ethanol. Infection by *B. acheilognathi* was noted in the field and confirmed in the laboratory where the number of tapeworms in the gastrointestinal tract of each fish was determined. Health condition indices and infestation rates and infra populations of *B. acheilognathi* and *Lernaea* were calculated.

Asian Fish Tapeworm

Fish were collected for monitoring prevalence and distribution of the Asian fish tapeworm (*B. acheilognathi*) throughout Grand Canyon, including the mainstem Colorado River and lower portion of tributaries. Due to the endangered status of humpback chub, they were collected in limited numbers and only from the vicinity of the LCR. Instead, speckled dace, fathead minnow and plains killifish were collected as surrogates since they are also known to be susceptible to this parasite (Brouder and Hoffnagle 1997c; Clarkson et al. 1997). Fish were preserved in 90% ethanol for laboratory examination where presence or absence of the tapeworm and number present were recorded.

Green Sunfish Diet

Green sunfish were collected opportunistically with conventional sport fishing tackle (rod, reel and artificial lures) from pool habitats in lower Kanab Creek, 1.2 to 2.4 km above its confluence with the Colorado River, on 27 June 1996. Upon capture, sunfish gastrointestinal (GI) tracts were removed and preserved in 90% ethanol. Prey items from the entire GI tract were enumerated to the lowest practical taxonomic level in the laboratory. Prevalence and number of each taxa found in the GI tracts were determined.

RESULTS AND DISCUSSION

Backwater Number

Backwater number decreased during the 1996 field season (Figure 3). During Trip 96-1, 68 backwaters were counted. Backwater number decreased to 42 on Trip 96-3 and 38 and 39 backwaters were counted on Trips 96-4 and 96-5, respectively.

Backwater number was affected by two main influences in 1996: the experimental flood and abnormally high summer discharge. The experimental flood moved much sand from the

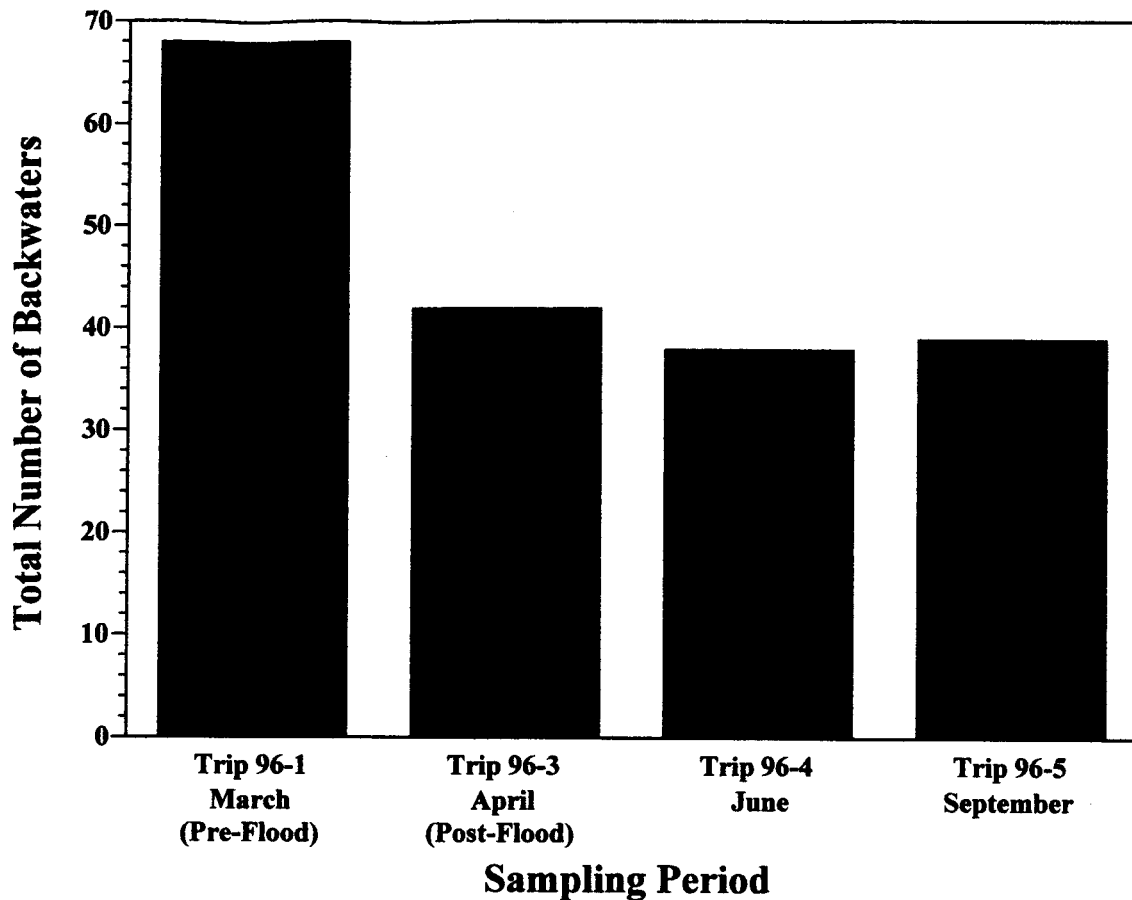


Figure 3. Total number of backwaters in the Colorado River between Lees Ferry and Diamond Creek during each AGFD Monitoring Trips 96-1, 96-3, 96-4 and 96-5 in Grand Canyon, Arizona, 1996.

river bed to the sides of the river, as planned. However, many of the sandbars that it created had very steep sides which eroded very quickly with the lowered discharges. Secondly, normal mean river discharge for April, June and September is 10 - 12,000 cfs. However, mean discharges during our trips in April, June and September were 18,162 cfs, 17,739 cfs and 14,365 cfs, respectively, which inundated backwater sites with mainchannel water. The data on backwater number presented here are only cursory. For a more detailed discussion of the effect of the experimental flood on backwater habitats the reader is directed to Brouder (1997) or Brouder et al. (*In review*).

Habitat Variables

Water temperature and turbidity have the greatest effect on fish behavior and catch rates (AGFD 1996b). Therefore, only these data are discussed here. Conductivity, DO (percent saturation), pH and redox potential, which are rarely found to be limiting to Grand Canyon fishes (AGFD 1996b), were also measured and these data are reported in Appendices 3 - 10.

Mainstem Colorado River

Mainstem water quality varied seasonally and among reaches (Appendices 3 - 8). Temperature and turbidity were the only water quality variables that ranged sufficiently to affect fishes. Temperature warmed seasonally and with distance downstream from Glen Canyon Dam. Turbidity was generally low but also increased with distance below Glen Canyon Dam.

Temperature

Temperatures varied seasonally and increased with distance downstream from Glen Canyon Dam, similarly to that seen previously (AGFD 1996b) and mean backwater temperature was always higher than mean mainchannel temperature (Figure 4; Appendix 3). Spring temperatures (Trips 96-1 and 96-3) were cool, with means of 10.74°C and 11.77°C (range: 9.3 - 15.5°C), respectively, in the mainchannel and 11.12°C and 12.42°C (range: 6.4 - 21.0°C), respectively, in backwaters. Mean temperatures increased during Trip 96-4 to 15.43°C and 13.08°C in backwaters and the mainchannel, respectively. Mean backwater (14.36°C) and mainchannel (13.29°C) temperatures during Trip 96-5 were similar to Trip 96-4. Temperatures rarely exceeded 20°C, which was achieved only in backwaters.

Relatively stable water temperatures in the Colorado River, Grand Canyon, are a result of Glen Canyon Dam (Stanford and Ward 1991). These cool summer temperatures affect the invertebrate community in Grand Canyon (Blinn and Cole 1991) and ultimately fish growth and survival (Valdez and Ryel 1995; AGFD 1996b). Backwaters, however, provide warmer and more productive habitat for larval and juvenile fishes than the mainchannel and this habitat may be improved if discharge fluctuations are reduced (Hoffnagle 1995; AGFD 1996b).

Turbidity

Turbidity in the Colorado River rarely exceeded 30 NTU in 1996 (Figure 5; Appendix 4). The notable exception to this was during Trip 96-5 when monsoonal rains caused the LCR to discharge sediment-laden water (>25,000 NTU) into the Colorado River. On this trip, turbidity in the mainchannel and backwaters, above the LCR, reached only 11.0 NTU, while below the LCR, turbidity ranged from 15 - 6872 NTU.

Decreased turbidity is another dramatic change in the Colorado River caused by Glen Canyon Dam. The water leaving Glen Canyon Dam is free of sediments (Andrews 1991) and usually remains clear as it flows through the Grand Canyon (AGFD 1996b). Tributaries provide sediment input when flowing above base levels, with the Paria and Little Colorado rivers providing the greatest amount of sediment input (Andrews 1991). Turbidity greater than approximately 30 NTU provides native fishes with sufficient cover to be active in nearshore areas during daylight (Valdez and Ryel 1995; AGFD 1996b).

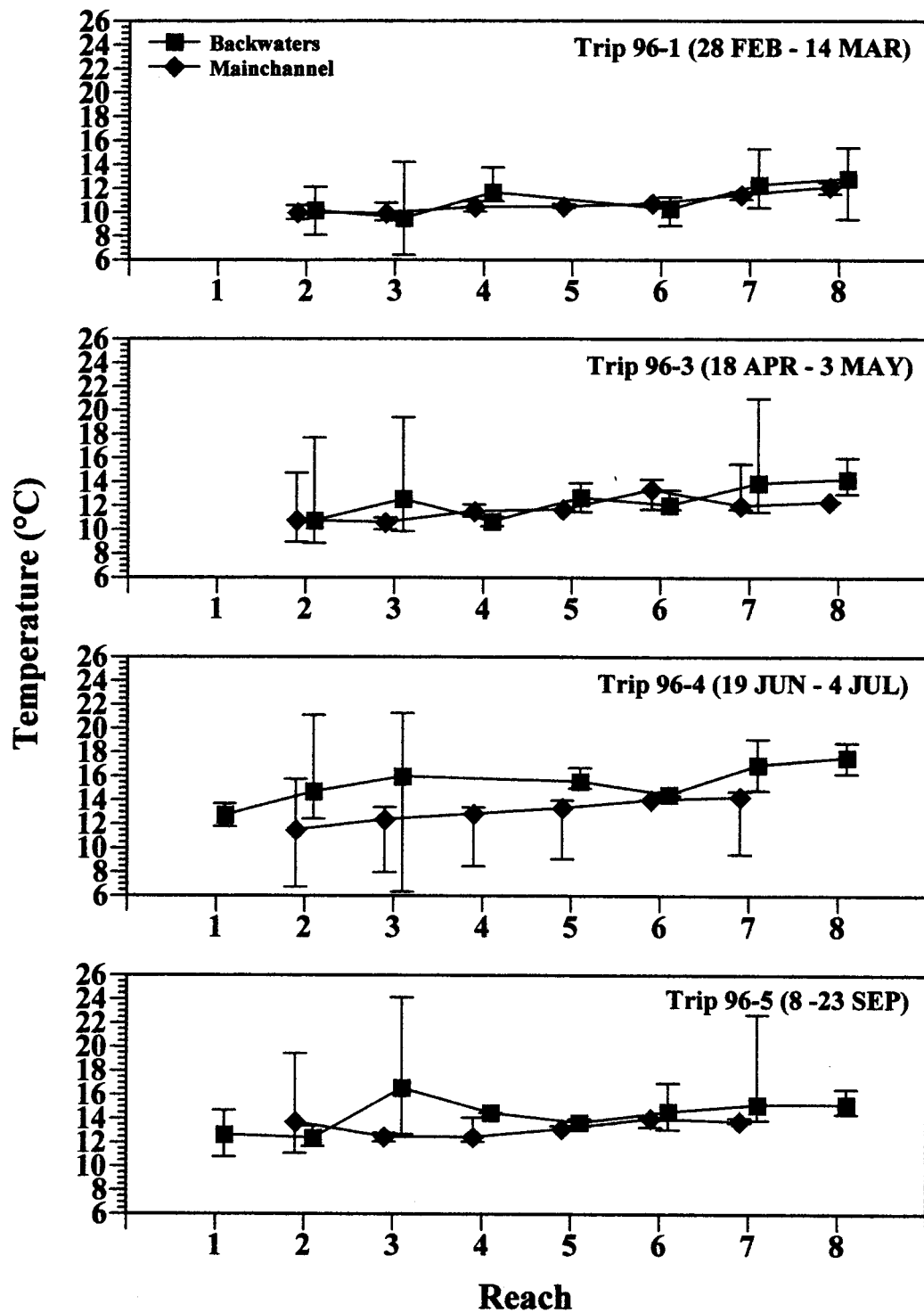


Figure 4. Mean and range of temperature (°C) measurements in backwaters and the mainchannel Colorado River during AGFD Monitoring Trips 96-1, 96-3, 96-4 and 96-5 in the Grand Canyon, Arizona, 1996.

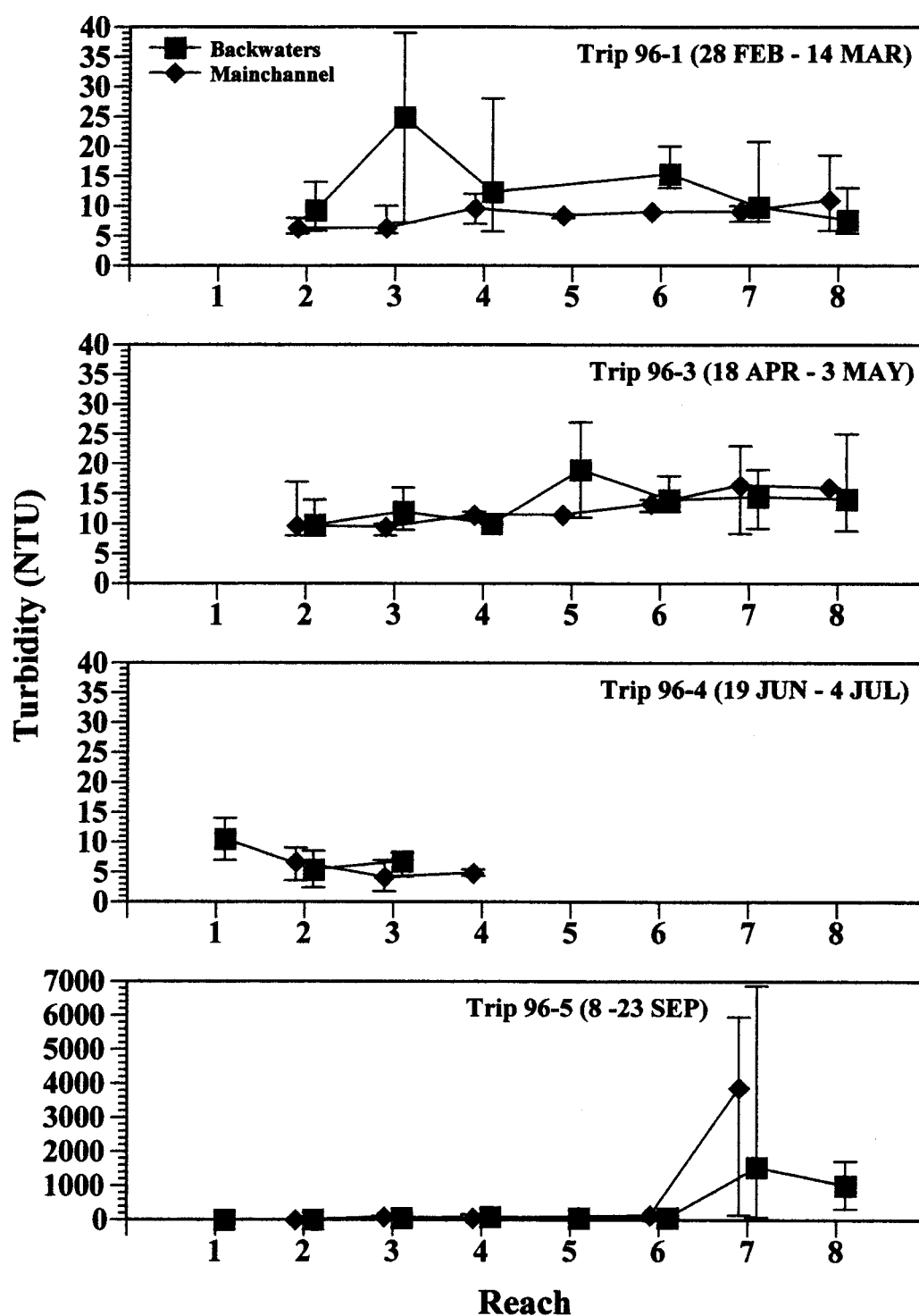


Figure 5. Mean and range of turbidity (NTU) measurements in backwaters and the mainchannel Colorado River during AGFD Monitoring Trips 96-1, 96-3, 96-4 and 96-5 in the Grand Canyon, Arizona, 1996.

Tributaries

Temperature and turbidity varied seasonally in each tributary (Appendices 9 - 10). Shinumo Creek was the coolest (10.5°C) on Trip 96-1 and LCR was the warmest (25°C) on Trip 96-4. Because of a drought in the southwestern United States in 1996, tributary discharges remained near base level throughout most of the year, causing turbidity to be generally low, ranging from 5.8 - 4.1 NTU with one exception. The LCR was flowing above base level on Trip 96-5 due to monsoonal rains when turbidity ranged from 6,500 - 25,750 NTU.

Sediment

The sediment composition of backwaters in the Colorado River, Grand Canyon, changed little during the four monitoring trips in 1996. During all trips, sand and silt were the major sediment components (Figure 6). The mean percentage of sand in backwater sediments ranged from 67.8 % during Trip 96-1 to 84.6 % during Trip 96-3 and mean percentage of silt ranged from 30.8 % during Trip 96-1 to 20.6 % during Trip 96-4. Organic matter (CPOM and FPOM) comprised a small fraction of the sediment contents, never exceeding 1.2%. Mean percentage of CPOM ranged from 0.1% during Trip 96-3 to 0.4% during Trip 96-5. Mean percentage of FPOM ranged from 0.6 - 0.9% on Trips 96-3 and 96-1, respectively.

There were no significant changes in the mean percentages of sand, silt or FPOM ($P \geq 0.1045$) in Colorado River backwaters during 1996. However, mean CPOM did vary among trips ($P = 0.0079$) and was significantly lower during Trip 96-3 than all other trips.

Sediment composition is important in benthic invertebrate community organization and productivity (Ward 1992). Arizona Game and Fish Department (1996b) found that coarse particles comprised 53.7 - 86.8% ($\bar{x} = 67.5\%$) and fine particles comprised 13.2 - 46.3% ($\bar{x} = 32.5\%$) of the backwater sediments annually from 1991 - 1994. Organic matter comprised 0.5 - 2.4% ($\bar{x} = 1.7\%$) of the sediments over this same period. Similarly, our 1996 results show that sand dominates, while organic matter comprises little of the sediment. They attributed variation in samples to differences in canyon morphology and the presence of tributaries, which provide sediments to Grand Canyon. In 1996, the experimental flood appeared to have removed some finer and organic particles. Trip 96-3 immediately followed the 1996 experimental flood, thus explaining the significant decrease in CPOM from backwaters. The experimental flood probably scoured CPOM from backwaters and it was not replaced during the descending limb of the experiment. Similarly, mean percentages of silt and FPOM also decreased between Trips 96-1 and 96-3, but not significantly. Mean percentage of sand increased between the pre- and post-flood trips, but also not significantly. However, by Trip 96-5, mean percentages of CPOM had exceeded pre-flood (Trip 96-1) levels. Recolonization of benthic invertebrates was probably hindered due to decreases of finer and more organically enriched sediments. However, it is expected that these components will continue to be deposited in backwaters, enriching the backwaters to the benefit of benthic invertebrates and, ultimately, fishes.

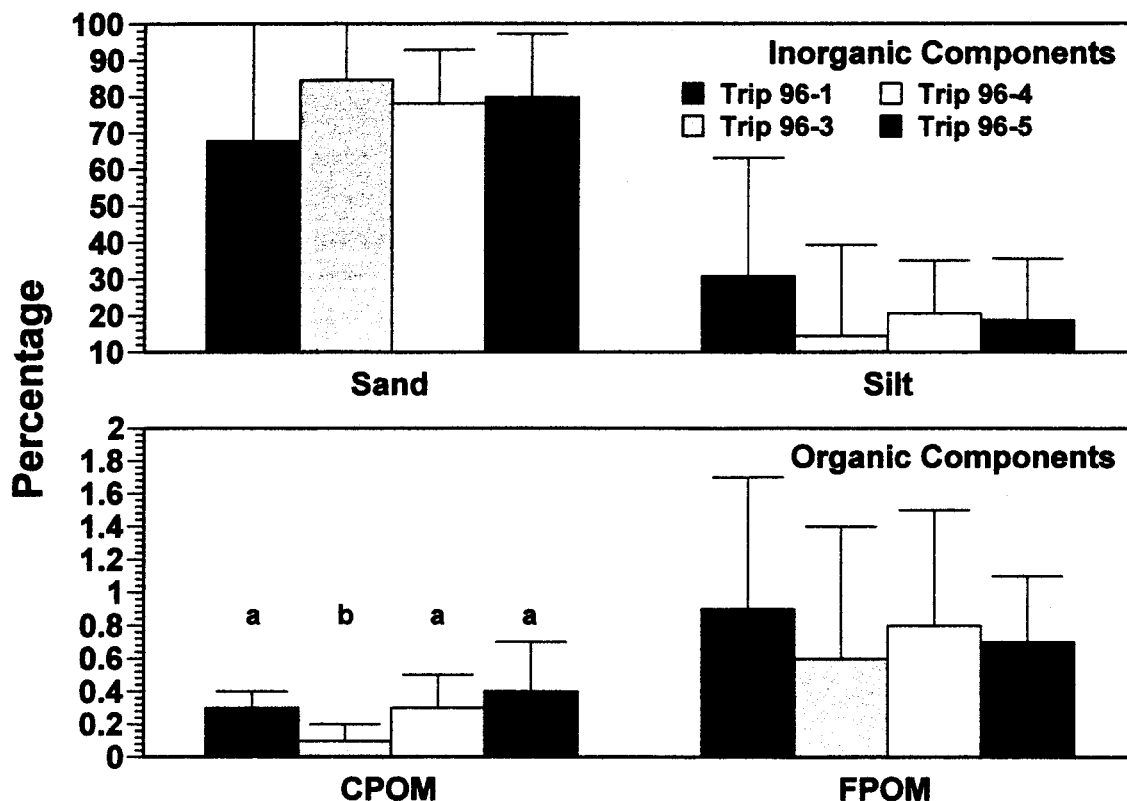


Figure 6. Mean percentages of inorganic (sand and silt; top) and organic (CPOM and FPOM; bottom) Colorado River backwater sediment components during AGFD Monitoring Trips 96-1, 96-3, 96-4 and 96-5 in the Grand Canyon, Arizona, 1996. Mean sand, silt and CPOM did not significantly vary among trips at $\alpha=0.05$. Mean CPOM varied among sampling periods and means with the same letter are not significantly different.

Zooplankton

Total zooplankton density differed significantly by sampling period ($P=0.0001$) and by reach ($P\leq 0.0137$), but not by habitat ($P=0.6332$). Total mean zooplankton density increased significantly between Trips 96-1 and 96-3 from $2205.6/\text{m}^3$ to $4413.7/\text{m}^3$ ($P=0.0001$; Figure 7). Total mean zooplankton density during Trip 96-4 did not differ significantly from Trip 96-3 ($P=0.5630$), but decreased significantly to $1300/\text{m}^3$ by Trip 96-5 ($P=0.0001$). Mean copepod density increased significantly from $349.3/\text{m}^3$ during Trip 96-1 to $798.0/\text{m}^3$ during Trip 96-3 ($P=0.0001$) and did not change significantly until Trip 96-5 ($116.7/\text{m}^3$; $P=0.0001$). Mean copepod nauplii densities increased from $569.0/\text{m}^3$ during Trip 96-1 to $2177.8/\text{m}^3$ during Trip 96-3 ($P=0.0001$), decreased to $1308.3/\text{m}^3$ during Trip 96-4 ($P=0.0031$) and decreased again by Trip 96-5 to $72.2/\text{m}^3$ ($P=0.0001$). Mean rotifer density did not change between Trips 96-1 and 96-3 ($P=0.2140$), increased from $1228.2/\text{m}^3$ during Trip 96-1 to $3716.7/\text{m}^3$ during Trip 96-4 ($P=0.0001$), but decreased to $1083.3/\text{m}^3$ by Trip 96-5 ($P=0.0001$). Mean branchiopod density did not vary significantly in 1996 ($47.6/\text{m}^3$; $P\geq 0.1486$). Analysis of covariance indicated that mean

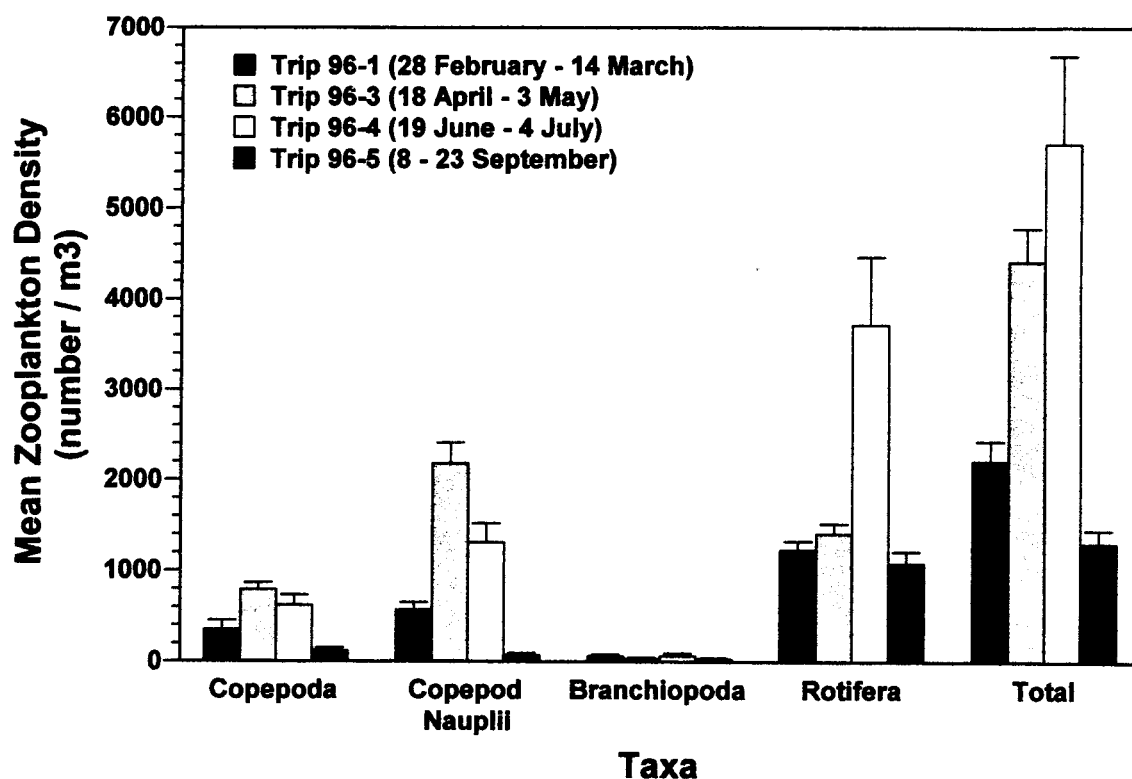


Figure 7. Mean zooplankton density (number / m³ ± 1 SD) during AGFD Monitoring Trips 96-1, 96-3, 96-4 and 96-5 in the Colorado River, Grand Canyon, Arizona, 1996.

water temperature was significantly correlated with sampling period ($P=0.0001$) and total zooplankton density ($P=0.0001$; Figure 7).

Mean zooplankton density also differed significantly among reaches ($P=0.0001$; Figure 8). During Trips 96-1 and 96-4, mean zooplankton density decreased in a linear fashion with distance downstream from Lees Ferry ($P \leq 0.0023$). During Trip 96-3, however, their distribution followed a higher order equation in which losses between RM 65.25 and RM 117.40 were minimal or nil and mean densities were lower at sites further downstream. Zooplankton longitudinal distribution during Trip 96-5 did not change longitudinally (Appendix 11).

Most zooplankton found in the Colorado River through Grand Canyon originates in Lake Powell, the mainstem reservoir formed by Glen Canyon Dam (Haury 1981; 1986). During the experimental flood, increased flow from Lake Powell may have imported unusually high numbers of zooplankton into the Colorado River. It is also possible that increases in zooplankton density following the experimental flood, particularly among Copepoda, were due to production resulting from increased water temperature (Allen 1976). While rotifer densities such as those observed during Trip 96-4 (3176.7 /m³) have rarely been observed in the Colorado River, rotifers were abundant (approximately 2000/m³) in April and May of 1991, the last year in which discharge from Glen Canyon Dam was allowed to fluctuate widely with no restriction on

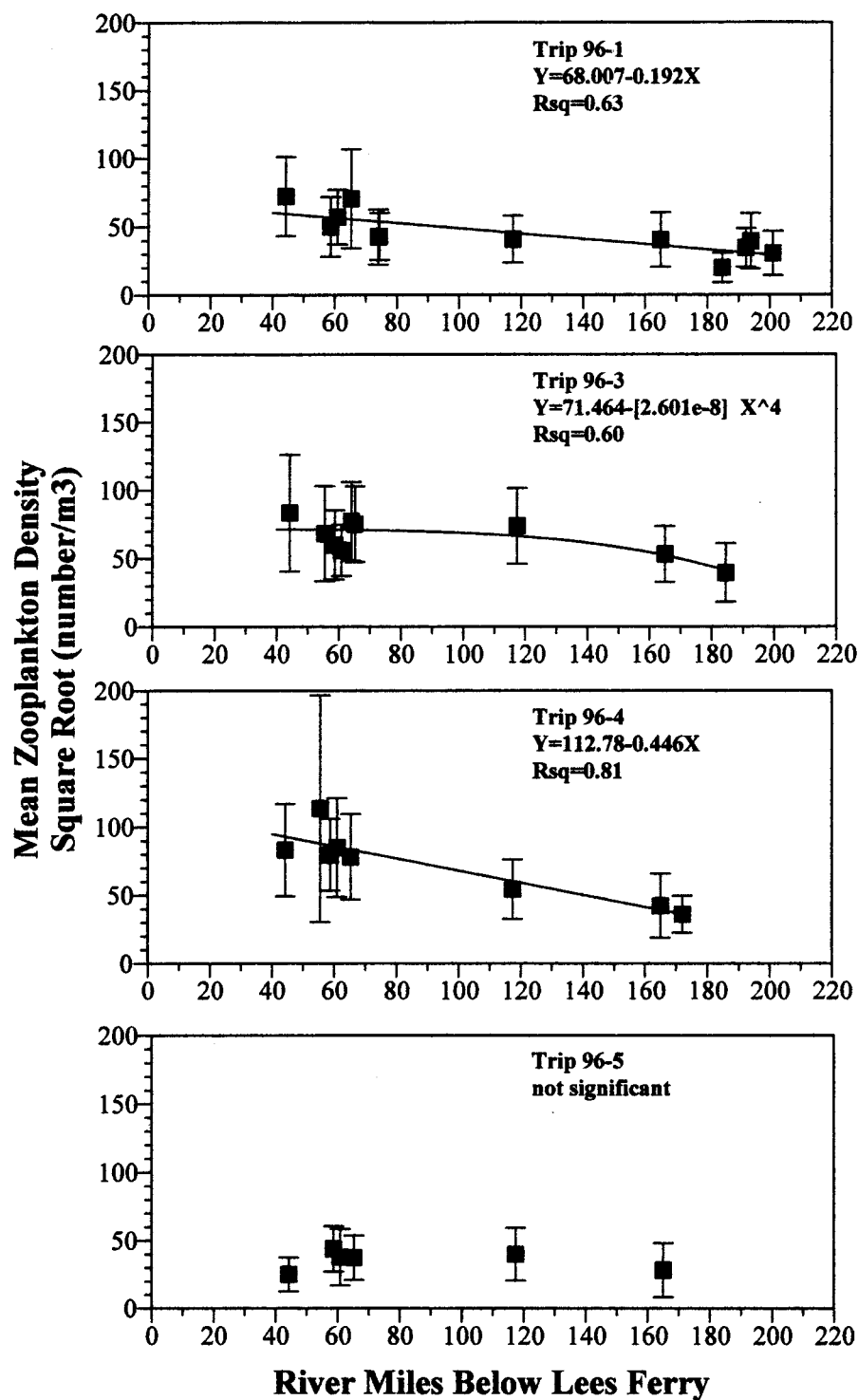


Figure 8. Mean zooplankton density (number / m³ ± 1 SD) among sampling locations (river mile) during AGFD Monitoring Trips 96-1, 96-3, 96-4 and 96-5 in the Colorado River, Grand Canyon, Arizona, 1996.

ramping rates (Valdez and Ryel 1995). The increase in rotifer density observed on Trip 96-4 may be a population response to disturbance effects of the experimental flood, which is typical of such 'r-selected' taxa (Allen 1976; Ferrari et al. 1989).

Whereas zooplankton density declined below RM 65.25 during Trips 96-1 and 96-4, no such decline occurred immediately following the experimental flood (Trip 96-3). Flooding events are capable of transporting zooplankton without observable longitudinal decreases in density (Chandler 1937; Hynes 1970; Walburg et al. 1981). The longitudinal distribution of zooplankton density commonly observed in the Colorado River through Grand Canyon (AGFD 1996b) was disrupted by the experimental flood, but resumed by Trip 96-4. No difference in zooplankton density was detected between backwater and mainchannel habitats due to high water exchange rates between the two habitats caused by daily fluctuations in dam discharge (AGFD 1996b).

Benthic Invertebrates

While densities of Chironomidae, other dipterans and miscellaneous invertebrates varied significantly among sampling periods ($P \leq 0.0036$; Figure 9; Appendix 12), no differences in mean total invertebrate density were detected ($P=0.0123$, $\alpha=0.005$). Densities of Chironomidae and miscellaneous dipterans declined significantly following the experimental flood (Trip 96-3; $P \leq 0.0364$) but their densities rebounded to pre-flood levels by Trip 96-4. Densities of miscellaneous invertebrates were greater than pre-flood levels ($P=0.0089$) during Trip 96-4 due to the presence of unidentified annelid worms. Total benthic invertebrate density varied by sampling location on Trip 96-1 ($P=0.0036$), but not on subsequent trips (Figure 10). During Trip 96-1, total density was greatest between RM 44.27 and RM 60.85.

Mean total AFDW invertebrate biomass did not vary significantly among the four sampling trips ($P=0.1682$; Figure 11). Mean biomass of Chironomidae and miscellaneous dipterans varied throughout 1996 ($P=0.0001$), decreasing following the experimental flood ($P \leq 0.0075$) but attaining pre-flood levels by Trip 96-4. Biomass of miscellaneous invertebrates (primarily unidentified annelid worms) increased following the experimental flood ($P=0.0034$).

Mean total benthic invertebrate density and biomass varied by sampling location on Trip 96-1 ($P \leq 0.0041$; Figure 10) but not on subsequent trips. Mean total invertebrate density and biomass were generally greatest between RM 44.27 and RM 60.85 during Trip 96-1. Mean detrital biomass differed among sampling periods ($P=0.0001$; Figure 12). Mean detrital biomass was highest during Trips 96-1 and 96-3 but declined during Trip 96-4 ($P=0.0001$). Mean detrital biomass did not vary significantly ($P=0.2999$) by sampling location.

Based on both density and AFDW estimates, dipterans in backwater habitats showed the least resistance to the 1996 experimental flood. Reduction in dipteran density and biomass during the month of April has not been observed in previous years (1991-1994; AGFD 1996b). While it is almost certain that the losses observed in 1996 were related to the experimental flood, it is unclear whether the losses were the direct result of sediment disturbance, dessication during the periods of steady low flows (8,000 cfs) which preceded and followed the flood, or both factors. Dipterans typically suffer population losses of 77-78% during spates (Ward 1992), but usually

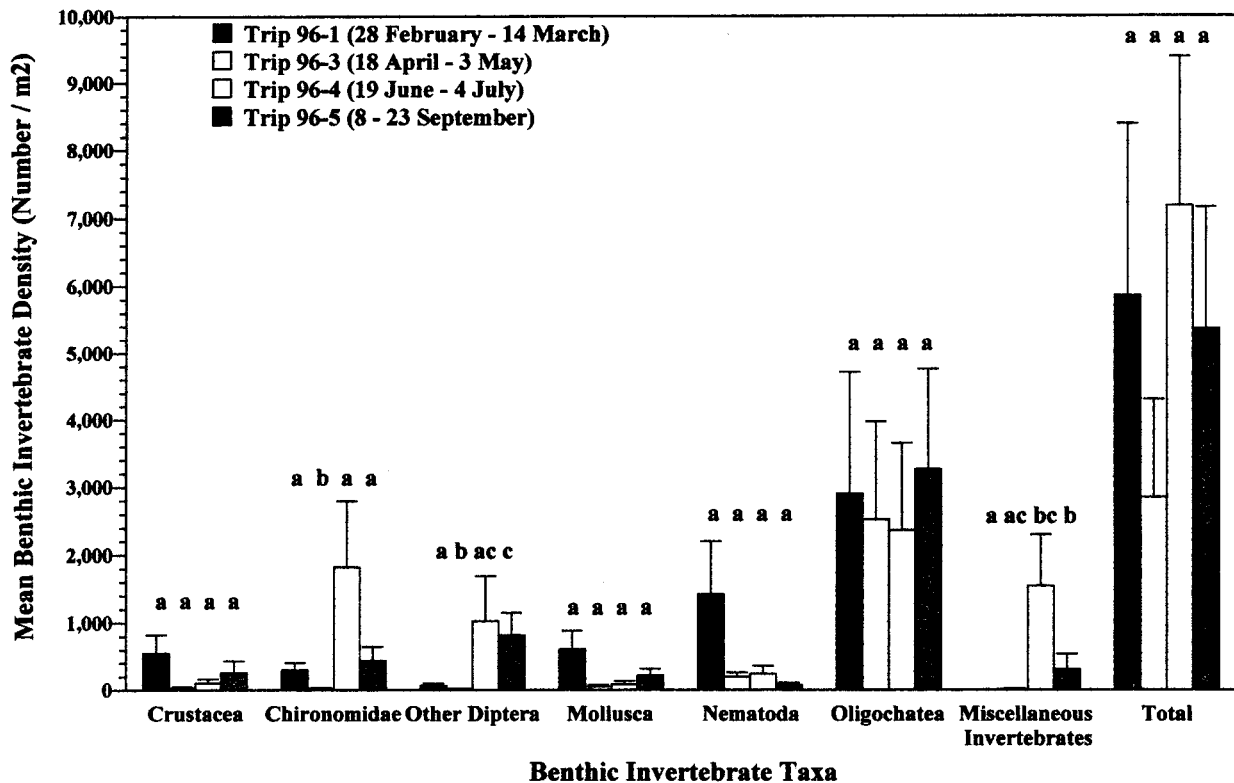


Figure 9. Benthic invertebrate density (\pm SEM) during AGFD Monitoring Trips 96-1, 96-3, 96-4 and 96-5 in the Colorado River, Grand Canyon, Arizona, 1996. Bars with the same letter (within each taxa) are not significantly different at $\alpha=0.05$.

recover to pre-spate levels within a mean of 0.42 yr (Niemi et al. 1990). Recovery of dipterans in the Colorado River following the experimental flood was rapid and well within the lower limit of 0.01 yr reported by Niemi et al. (1990). Shannon et al. (1996) reported similar results for all benthos collected from cobble riffles on the Colorado River, Grand Canyon, during the experimental flood. Oligochaete density was unaffected by the flood, possibly due to their use of the hyporheic zone as refuge from flooding (Poole and Stewart 1976; Irvine 1985) or rapid recolonization from the drift (Palmer et al. 1992), of which they comprised up to 90% during the flood (Shannon, personal communication).

Losses of chironomids and other dipterans following the experimental flood may potentially impact nutrition of native fishes. Chironomid and simuliid larvae are usually numerically dominant in gut contents of native fishes, particularly the endangered humpback chub (Kaeding and Zimmerman 1983; AGFD 1996a; b; Valdez and Ryel 1995; Valdez and Hoffnagle *In review*).

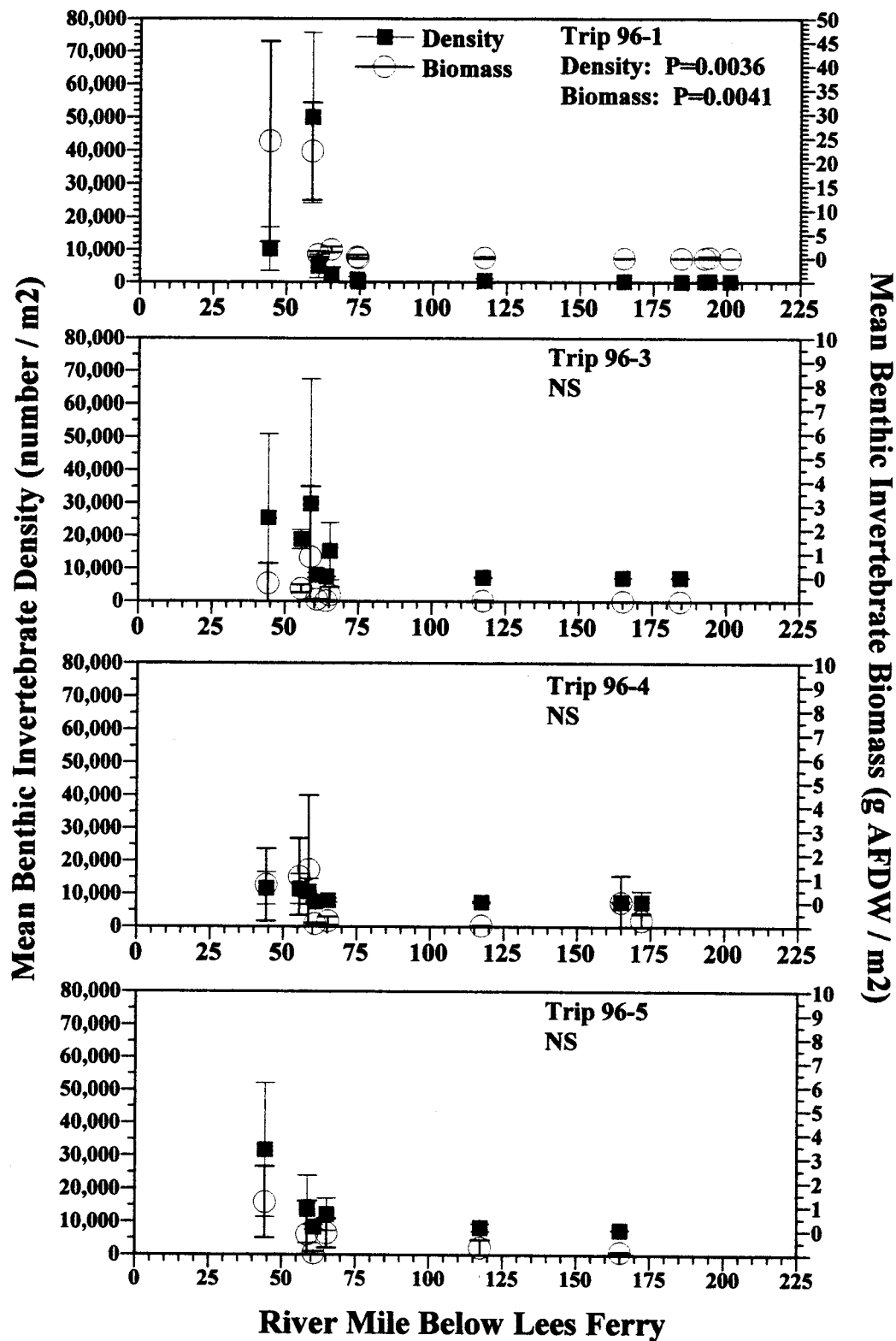


Figure 10. Longitudinal distribution of benthic invertebrate density (number / $m^2 \pm SD$) and biomass (g AFDW / $m^2 \pm SD$) during AGFD Monitoring Trips 96-1, 96-3, 96-4 and 96-5 in the Colorado River, Grand Canyon, Arizona, 1996. NS=no significant differences at $\alpha=0.05$.

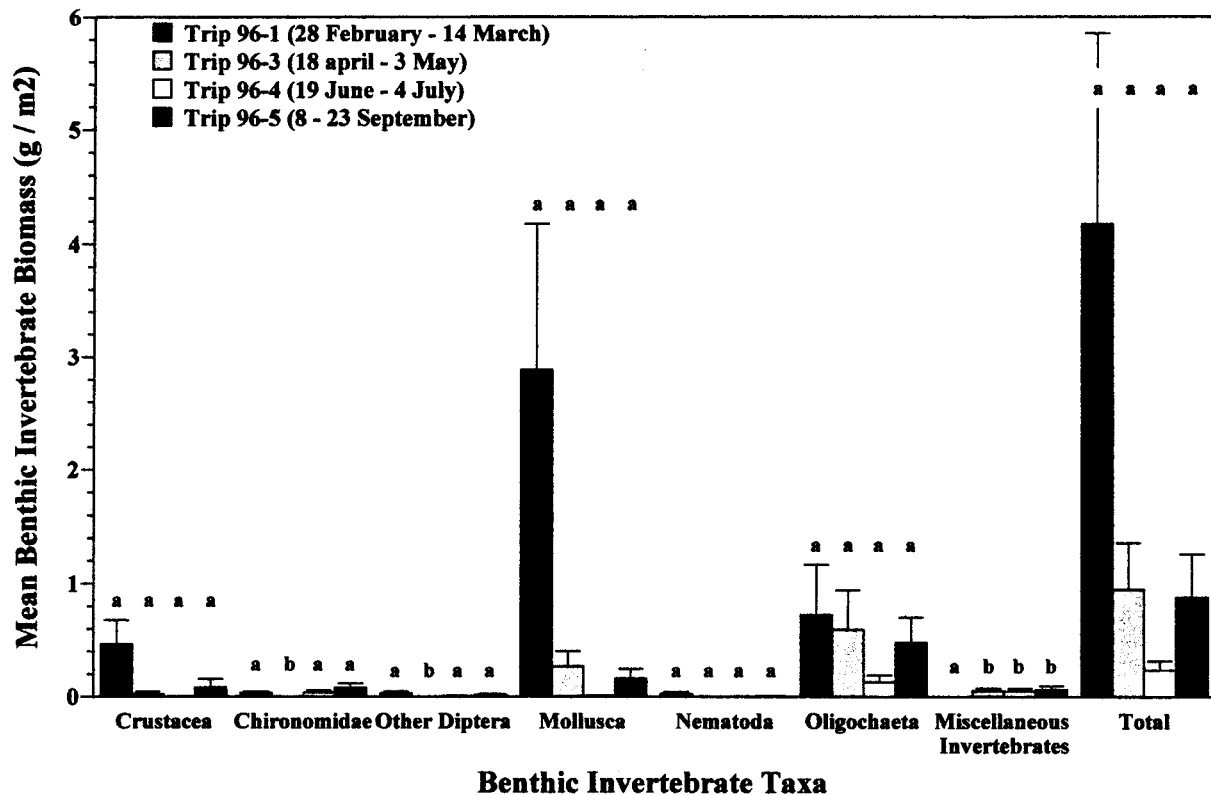


Figure 11. Benthic invertebrate biomass (\pm SEM) collected during AGFD Monitoring Trips 96-1, 96-3, 96-4 and 96-5 in the Colorado River, Grand Canyon, Arizona, 1996. Bars with the same letter (within each taxa) are not significantly different at $\alpha=0.05$.

Fish Abundance

A considerable amount of effort was expended during our fish collections. Relative abundance of each species varied seasonally and longitudinally from Lees Ferry to Diamond Creek. As previously reported (AGFD 1996b), fishes were more common in the vicinity of known or suspected spawning sites, particularly tributaries. Seasonal patterns of abundance were related to spawning migrations and the appearance of YOY fish. Additionally, the experimental flood affected abundance of some species, but their recovery was rapid (Hoffnagle 1996; Hoffnagle et al. *In review*).

Sampling Effort

Five gear types, seines, trammel nets, minnow traps, hoop nets and electrofishing, were used to collect fishes in three different habitat types, Colorado River backwaters, mainchannel Colorado River and tributaries (Table 2; Appendix 13). A total of 135 seining samples in backwater sites covered 18,448 m², and an additional 33 mainchannel sites totaled 5,893 m² of effort. One hundred thirty-one electrofishing samples were conducted in the mainchannel, for a

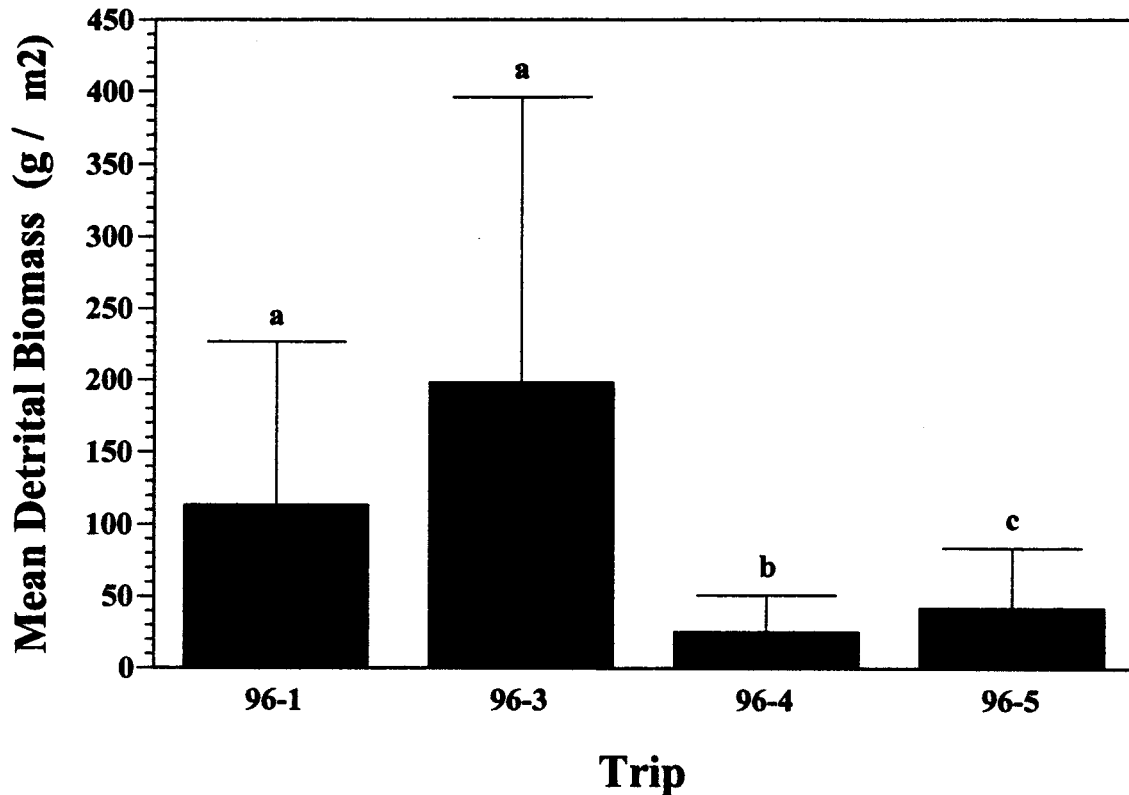


Figure 12. Mean detrital biomass ($\text{g} / \text{m}^2 \pm \text{SD}$) in backwaters during AGFD Monitoring Trips 96-1, 96-3, 96-4 and 96-5 in the Colorado River, Grand Canyon, Arizona, 1996. Letters indicate significant differences among trips at $\alpha=0.05$.

total of 150,339 seconds of effort. One hundred twenty-nine mainchannel trammel net sets totaled 268.31 hours of effort. Minnow traps were the only gear to be used in all three habitat types, although sparingly in backwaters (three sites for 52.46 hours). In the mainchannel, 171 groups of minnow traps were set for a total of 4402.3 hours. Thirty-one groups of minnow traps were set at tributary sites for a total of 479.08 hours. Hoop nets were set in tributaries for a total of 860.67 hours in 40 sets.

Seasonal Variation in Catch

Catch-per-unit-effort varied among trips (Figures 13 - 16; Appendices 14 - 15) for two reasons. First, catch varied seasonally with changes in capture susceptibility (e.g., adults are more susceptible when congregated in spawning aggregations) and changes in numbers (e.g., increased catches in summer when YOY appear). Second, the experimental flood affected abundance of fathead minnow, plains killifish and rainbow trout (*Oncorhynchus mykiss*) (Hoffnagle 1996; Hoffnagle et al. *In review*).

Table 2. Amount of effort expended and number of sites sampled in each habitat and with each gear type during each AGFD monitoring trip in the Colorado River and tributaries, Grand Canyon, Arizona, 1996.

Gear/Habitat	Trip '96-1		Trip 96-3		Trip 96-4		Trip 96-5		Total	
	Effort	# Sites	Effort	# Sites	Effort	# Sites	Effort	# Sites	Effort	# Sites
<u>Seines (m²)</u>										
Backwater	4,342	34	6,133	31	3,875	30	4,098	40	18,448	135
Mainchannel	2,818	10	1,056	6	1,006	10	1,013	7	5,893	33
<u>Electrofishing (sec)</u>										
Mainchannel	100,088	33	16738	35	22,326	40	11187	23	150,339	131
<u>Trammel Nets (hr)</u>										
Mainchannel	58.92	33	60.9	31	52	30	96.49	35	268.31	129
<u>Minnow Traps (hr)</u>										
Backwater	37.53	2	14.93	1	0	0	0	0	52.46	3
Mainchannel	832.59	40	1,201.89	62	1,253.29	60	1,114.53	56	4,402.3	171
Tributary	105.97	6	116.99	8	115.52	8	140.6	9	479.08	31
<u>Hoop Nets (hr)</u>										
Tributary	45.98	3	43.58	3	257.11	13	514	21	860.67	40

Bluehead Sucker

Bluehead sucker catches were low during Trips 96-1 and 96-3 except for adults, which were caught at a rate of approximately 4 fish / 12 hour hoop net set in tributary mouths (Figures 13 and 14). Backwater seining catch increased from < 0.3 fish / 100 m^2 seined to $12.7 / 100 \text{ m}^2$ during Trip 96-4 with the appearance of YOY's and hoop net catches decreased to 0.4 fish / 12 hours with the end of the spawning season (Figure 15). During Trip 96-5, bluehead sucker catches increased in minnow traps (0.05 fish / 24 hours), but decreased in backwaters ($2.7 / 100 \text{ m}^2$), as the juveniles became large enough to withstand the mainchannel and had begun to develop their cartilaginous scraper for feeding on rocky substrates (Figure 16). Adult catches also increased in trammel nets during this period to 3.6 fish / 100 hours.

Flannelmouth Sucker

Flannelmouth sucker catches were high in both hoop nets set in tributary mouths (8.5 fish / 12 hours) and in trammel nets (47.2 fish / 100 hours) during Trip 96-1 (Figure 13). During Trip 96-3, hoop net catches increased to 57.9 fish / 12 hours while trammel net catches decreased to 1.3 fish / 100 hours (Figure 14). Hoop net catches were lower during Trip 96-4, at 8.6 / 12 hours, with the end of the spawning season (Figure 15). However, seining catch rate increased dramatically from < 0.5 fish / 100 m^2 seined to $10.1 / 100 \text{ m}^2$ with the dispersal of YOY suckers from spawning tributaries into backwaters. During Trip 96-5, adult hoop net catches declined further (1.4 / 12 hours) but trammel net catches increased to 8.5 fish / 100 hours (Figure 16). Backwater seining catches also decreased (2.9 fish / 100 m^2).

Humpback Chub

Catches of adult humpback chub were high (~ 24 fish / 100 hours) in trammel nets during Trips 96-1 and 96-3 (Figures 13 and 14). Electrofishing catches of juveniles was 0.489 fish / 10 minutes and remained relatively steady throughout the field season. Trammel net catches decreased to 3.9 fish / 100 hours during Trip 96-4 while catches of YOY humpback chub in backwaters increased from < 0.4 fish / 100 m^2 to $2.8 / 100 \text{ m}^2$ as fish dispersed from the LCR (Figure 15). Backwater seining catch nearly doubled ($4.7 / 100 \text{ m}^2$) and minnow trap catches tripled (0.25 fish / 24 hours) as monsoon spates dispersed YOY humpback chub from the LCR during Trip 96-5 (Figure 16). Catches of adults in trammel nets also increased to 16.8 fish / 100 hours during this trip.

Speckled Dace

Speckled dace catches were low in all gears during Trips 96-1 and 96-3 (Figures 13 and 14). However, catch rates for speckled dace increased dramatically from < 2.5 fish / 100 m^2 to $58.2 / 100 \text{ m}^2$ in backwaters and decreased from approximately 0.23 fish / 10 minutes to 0.09 / 10 minutes in electrofishing during Trip 96-4 as the backwaters warmed to temperatures greater than that of the mainchannel (Figure 15). Seine catches decreased during Trip 96-5 to $8.2 / 100 \text{ m}^2$ (Figure 16).

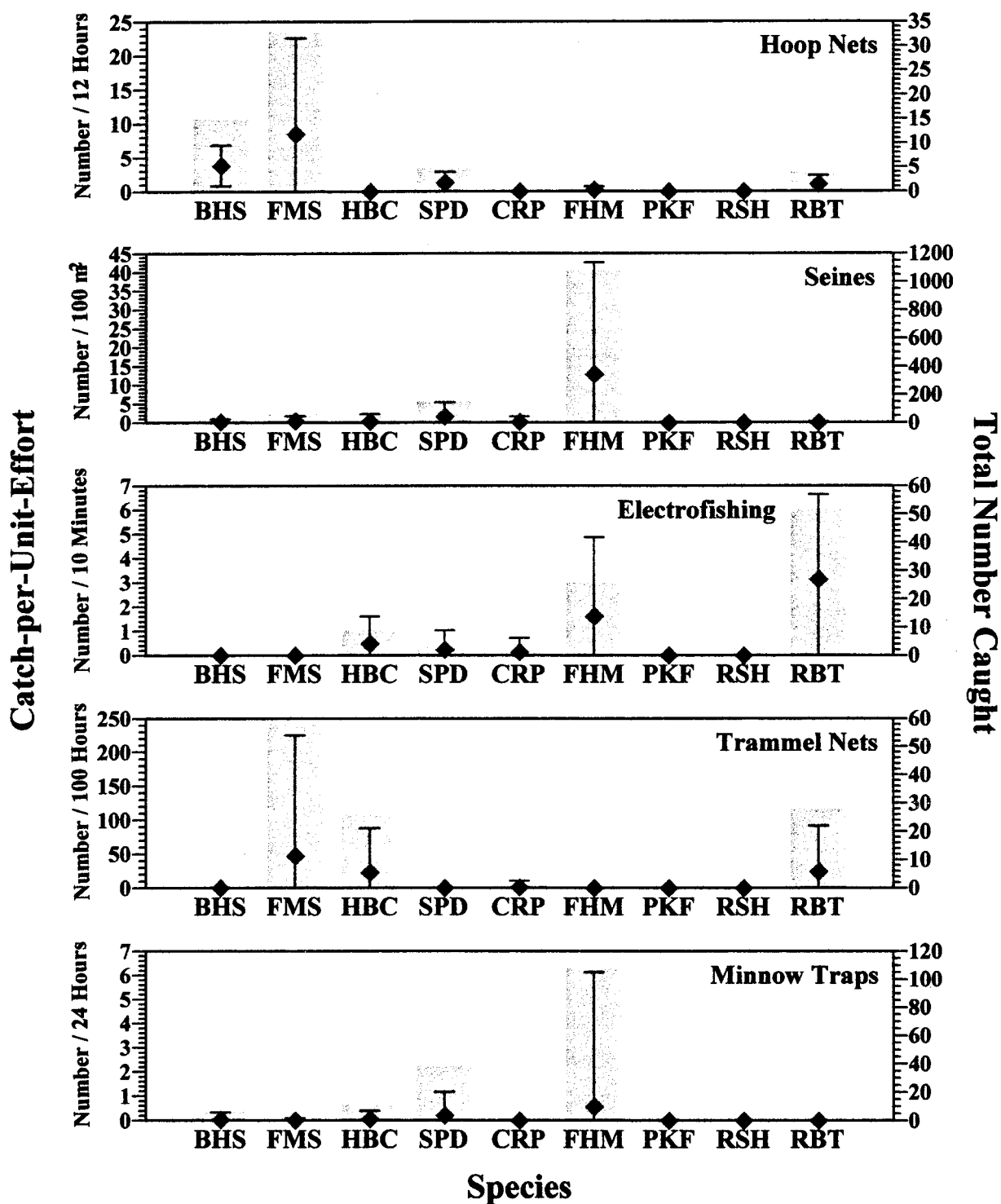


Figure 13. Mean catch-per-unit-effort (points and standard deviations) and total catch (columns) of native and commonly captured non-native species in the Colorado River and tributaries, Grand Canyon, Arizona, in each gear type used during AGFD monitoring Trip 96-1, 28 February - 14 March 1996.

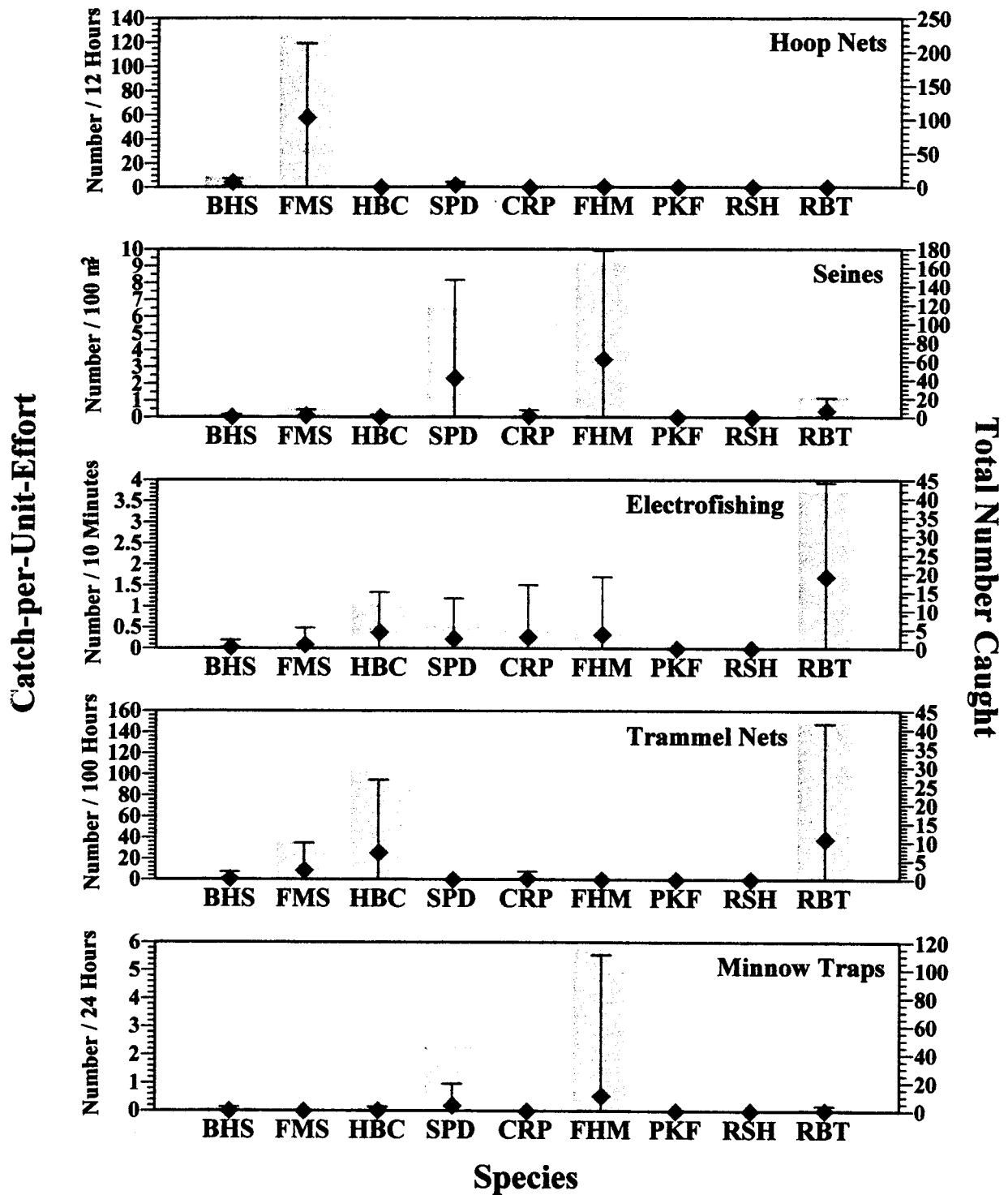


Figure 14. Mean catch-per-unit-effort (points and standard deviations) and total catch (columns) of native and commonly captured non-native species in the Colorado River and tributaries, Grand Canyon, Arizona, in each gear type used during AGFD monitoring Trip 96-3, 18 April - 3 May 1996.

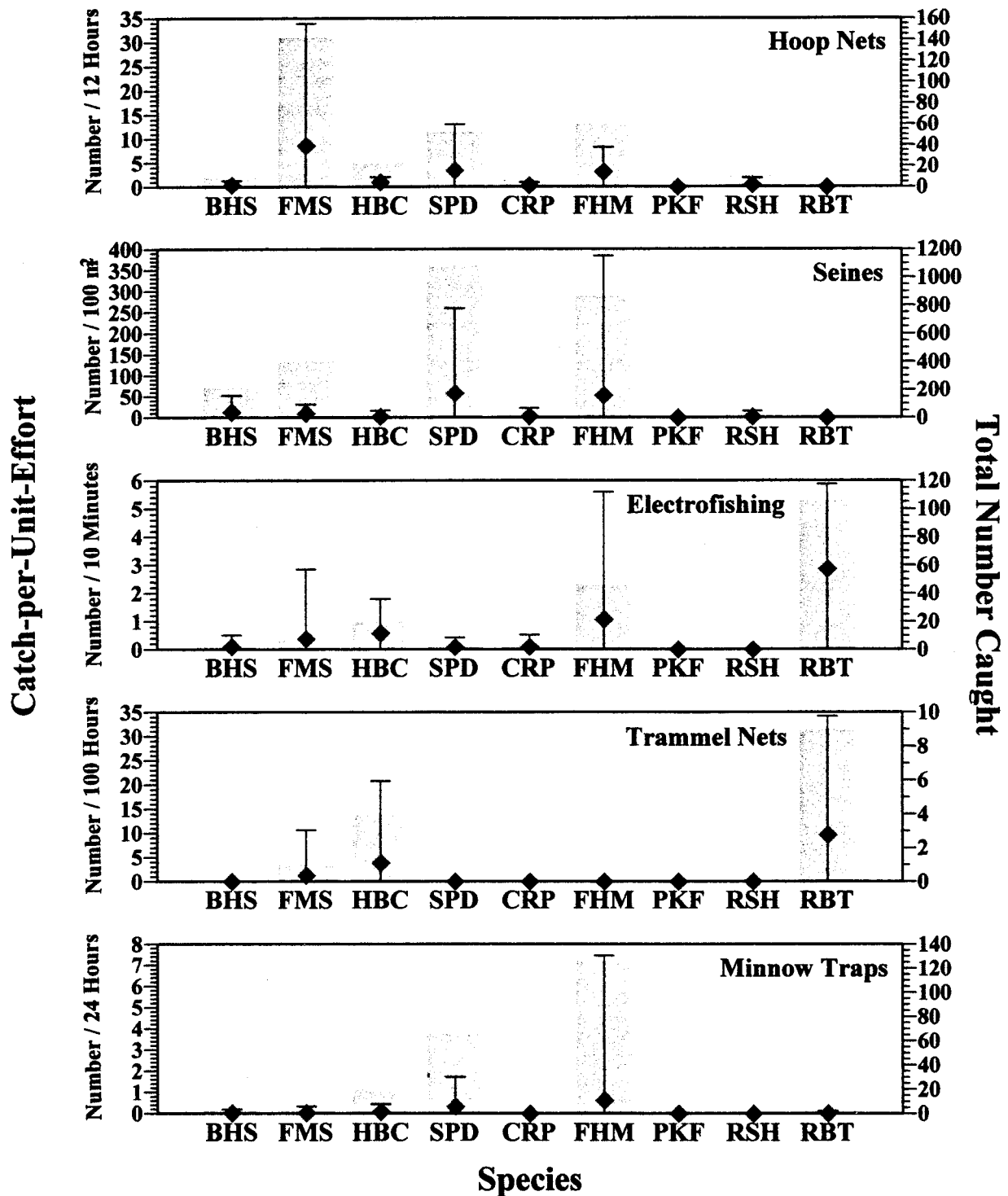


Figure 15. Mean catch-per-unit-effort (points and standard deviations) and total catch (columns) of native and commonly captured non-native species in the Colorado River and tributaries, Grand Canyon, Arizona, in each gear type used during AGFD monitoring Trip 96-4, 19 June - 4 July 1996.

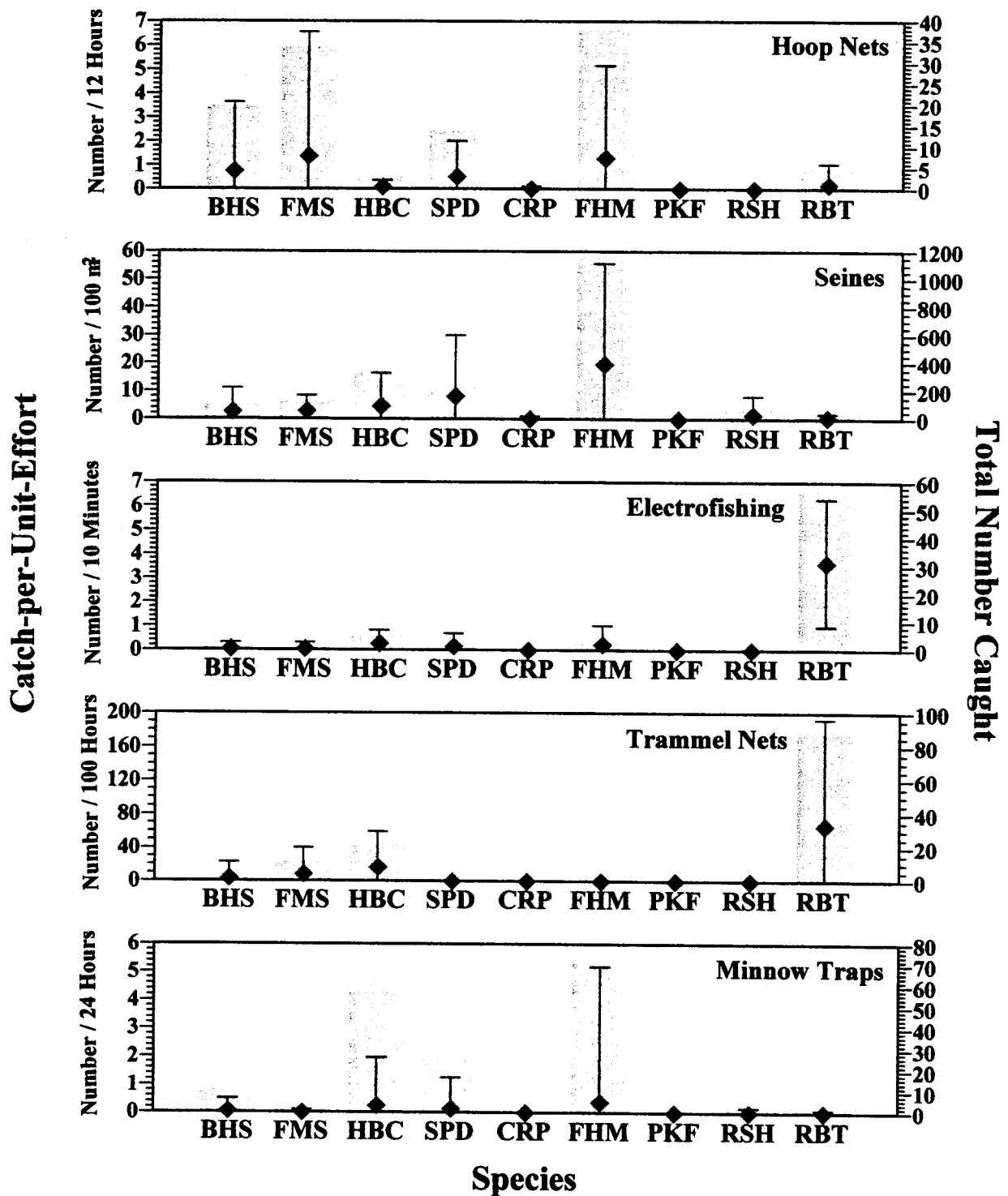


Figure 16. Mean catch-per-unit-effort (points and standard deviations) and total catch (columns) of native and commonly captured non-native species in the Colorado River and tributaries, Grand Canyon, Arizona, in each gear type used during AGFD monitoring Trip 96-5, 8 - 23 September 1996.

Common Carp

Catches of common carp (*Cyprinus carpio*) were low in all gears throughout the summer with one exception (Figures 13 - 16). Mean catch rate of YOY common carp in backwaters during Trip 96-4 was 3.003 fish / 100 m² seined, approximately 20 times that of the other three sampling periods.

Fathead Minnow

Fathead minnow abundance was affected by the experimental flood, with decreases in catch between Trips 96-1 and 96-3 in both backwater seining and by electrofishing (Figures 13 and 14). Backwater seining catch decreased from 13 to 3.5 fish / 100 m² seined. Electrofishing catch decreased from 1.6 fish / 10 minutes to 0.34 fish / 10 minutes. However, this species rebounded quickly by Trip 96-4, likely from tributary refugia, where hoop net catch increased from 0.5 to 3.1 fish / 24 hours, and reproduction in backwaters, where catch rebounded to 53 fish / 100 m² seined (Figure 15). Electrofishing catch also increased to 1.1 fish / 10 minutes during Trip 96-4. During Trip 96-5, backwater seining catch decreased to nearly 20 fish / 100 m², still higher than before the flood (Figure 16).

Plains Killifish

Plains killifish are found only in tributaries and backwaters in Grand Canyon (AGFD 1996a; b) and were also affected by the flood. Plains killifish mean CPUE in backwaters decreased from 0.9 fish/100 m² seined (43 fish) before the flood to 0 fish/100 m² afterwards (Figures 13 and 14). A few plains killifish were captured in backwaters during Trip 96-4 (Figure 15), but catches during Trip 96-5 reached 2.1 fish / 100 m², exceeding all previous catches in 1996 (Figure 16). Plains killifish recolonized mainstem backwaters from tributary refugia and were also benefitted by the unusually high and steady discharge from Glen Canyon Dam throughout 1996, which provided them with good spawning and rearing habitat.

Red Shiner

Red shiner (*Cyprinella lutrensis*) were common at Lees Ferry in 1967 - 1968 (Stone and Rathbun 1968). However, the cold water discharged from Glen Canyon Dam following the filling of Lake Powell caused them to become rare in Grand Canyon above Diamond Creek prior to this year (Valdez and Ryel 1995; AGFD 1996b). However, it appears that lack of flooding in the LCR allowed an increase in their numbers and an expansion into the mainstem Colorado River. No red shiners were caught during Trips 96-1 and 96-3 (Figures 13 and 14). However, during Trip 96-4 red shiner were captured at mean rates of 2.4 / 100 m² in mainstem backwaters and 0.45 fish / 12 hours in hoop nets from the LCR for a total of 48 fish captured (Figure 15). On Trip 96-5 more fish were caught (74) but the capture rate diminished to 1.6 / 100m² seined (Figure 16). Three red shiners (0.01 fish / 24 hours) were also caught in minnow traps during Trip 96-5.

Rainbow Trout

Rainbow trout appear to have been dispersed downstream by the flood, since they were commonly captured in downstream areas where they had previously been rare. During Trip 96-1 adult rainbow trout were commonly captured in trammel nets (24.4 fish / 100 hours) and by electrofishing (3.1 fish / 10 minutes) but all sizes of rainbow trout were captured at a rate of only 0.06 fish / 100 m² in backwaters (Figure 13). Following the flood (Trip 96-3) catch rates in trammel nets increased to 38.6 fish / 100 hours but electrofishing decreased to 1.7 / 10 minutes (Figure 14). However, catches of rainbow trout in backwaters increased to 0.4 fish / 100m² and remained high throughout the field season (Figures 15 and 16). Catches of rainbow trout by electrofishing increased through the summer to 3.6 fish / 10 minutes by Trip 96-5. Trammel net catches decreased on Trip 96-4 (9.7 fish / 100 hours) but increased dramatically to 66.9 fish / 100 hours during Trip 96-5.

Species Composition

Fish composition within each reach or tributary largely reflects which species spawn in that area. Additionally, some non-native species (i.e., plains killifish and green sunfish) remain closely linked to the tributary from which they appear to have invaded Grand Canyon.

Mainstem Colorado River

Species composition in the mainstem Colorado River varies among reaches for several reasons. The mainstem Colorado River is generally colder and clearer in the upper reaches and warms and becomes, at least slightly, more turbid as it travels downstream and receives input from tributaries, making some reaches more suitable for certain species (AGFD 1996b). Additionally, the presence of spawning areas or tributaries within a given reach will increase the abundance of fish that use these areas. Some of the native species drift as larvae, but do not tend to drift far beyond the mouth of the tributary in which they are spawned (AGFD 1996b). Cold temperatures may lead to mortality of those that do not find refuge soon upon entry into the mainstem Colorado River (Clarkson and Lupher 1994; AGFD 1996b; Childs and Clarkson 1996).

Reach 1

Reach 1 was sampled very little during 1996 and only three fish (0.04% of the total catch) of two species were captured: two speckled dace and one rainbow trout (Figure 17). This reach of river is depauperate of species and has been dominated by rainbow trout and speckled dace, although some adult flannelmouth sucker and a rare brown trout (*Salmo trutta*) have been captured here (Valdez and Ryel 1995; AGFD 1996b). Flannelmouth sucker spawn in the Paria River (Weiss 1993; AGFD 1996b) but no larvae or juveniles have been captured in the mainstem Colorado River nearby (AGFD 1996b).

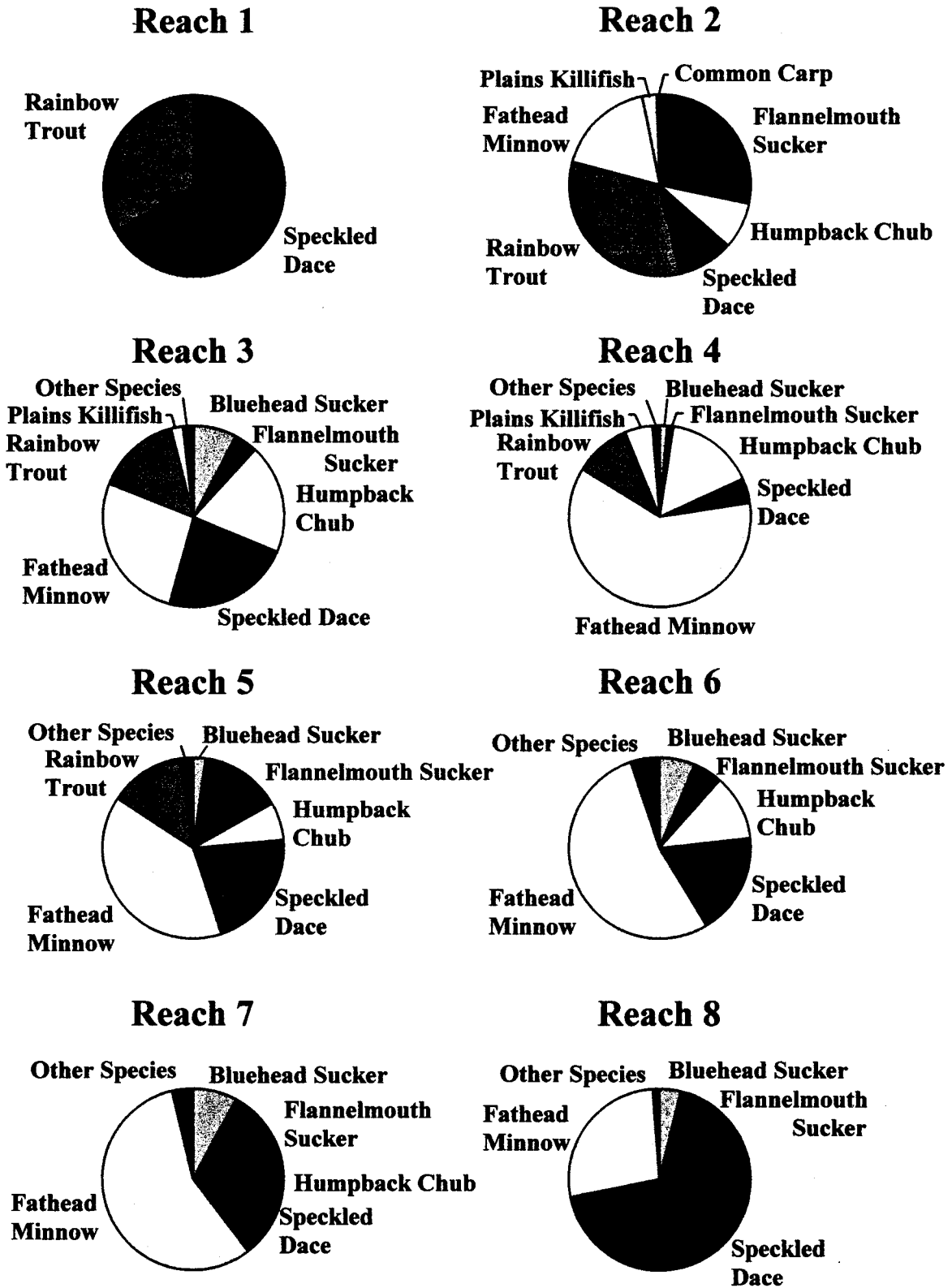


Figure 17. Species composition of the total catch in each reach during AGFD Monitoring in the Colorado River, Grand Canyon, 1996.

Reach 2

The LCR is the lower boundary of Reach 2 and the number of species found increased to seven (Figure 17). A total of 498 fish was captured, comprising 7.3% of all of the fish caught in 1996. Rainbow trout were dominant (32.7%) and speckled dace remained common (9.8%). However, flannemouth sucker (28.3%) and humpback chub (8.2%) also became common. Non-native fathead minnow (17.7%), plains killifish (2.6%) and common carp (0.6%) populated the lower portions of Reach 2, probably having moved upstream from the LCR.

In 1993 and 1994, AGFD regularly caught low numbers of juvenile (20 - 50 mm TL) humpback chub in a backwater at RM 44.27 L (AGFD 1996b). These fish were too small to have been spawned in the LCR and migrated 17 miles upstream through several large rapids. We speculated that these fish might have been spawned in a series of warm springs in the vicinity of RM 30, at the top of Reach 2, since an aggregation of adults was known from that area (Valdez and Ryel 1995). In 1995, Bio/West found about 100 post-larval humpback chub in the warm plume of one of these springs. Although mainstem spawning is encouraging, no evidence of recruitment of any young into this adult population has been found. Previous studies have found some bluehead suckers in the lower portion of this reach (AGFD 1996b). Additional non-native species that have incidentally been found here include brown trout, channel catfish (*Ictalurus punctatus*) and green sunfish (AGFD 1996b).

Reach 3

Reach 3 is situated immediately below the LCR, which is the spawning site for at least ten species of native and non-native fishes. This area was sampled intensively and 1,156 fish were caught, comprising 16.9% of the fish captured. Fathead minnow dominated here, comprising 26.7% of the total number of fish caught (Figure 17). However, all four remaining native species were well represented with speckled dace comprising 22.9%, humpback chub 19.5%, bluehead sucker 7.7% and flannemouth sucker 4.2% of the total catch here. Rainbow trout were still common (15.0%) with plains killifish (2.2%), common carp (0.9%), red shiner (0.7%) and brown trout (0.3%) also present.

This reach is where all four remaining native species become common. However, non-native species appear to be increasing their presence here. Plains killifish have been increasing since 1991 and red shiners appeared for the first time this year (AGFD 1996b). The presence of brown trout and channel catfish in Reach 3 is detrimental to native fishes which are preyed upon by these non-natives (Valdez and Ryel 1995; Marsh and Douglas 1997). Black bullhead (*Ameiurus melas*) have been found here in the past (Valdez and Ryel 1995), but remain rare.

Reach 4

Reach 4 runs from Lava Chuar Rapid to Hance Rapid, at the top of the Upper Granite Gorge. This reach contained the same species as Reach 3, but their composition changed (Figure 17). This reach was also sampled fairly intensively and 1,599 fish (23.4%) were captured.

Fathead minnow became more dominant, comprising 61.0% of the total catch. Humpback chub were still common (15.8%) and speckled dace (4.4%), bluehead sucker (1.4%) and flannelmouth sucker (1.0%) were also still captured. Plains killifish (4.9%) increased in relative abundance and common carp, brown trout and red shiner each comprised <1% of the total catch in Reach 4.

Reach 4 is important because it also contains fairly large numbers of humpback chub. However, PIT tagging studies have shown that no humpback chub captured below Lava Chuar Rapid have been found above, so any humpback chub dispersing into Reach 4 are lost to the LCR spawning population (Valdez and Ryel 1995). Since there are no suitable spawning areas in Reach 4, these fish are likely lost to the reproducing population, except in the unlikely event that they migrate further downstream and find a suitable area there. Fathead minnow and plains killifish were common in the still water of submerged vegetation in this reach. Channel catfish and brook trout (*Salvelinus fontinalis*) have been reported as incidentals in this area (AGFD 1996b).

Reach 5

Reach 5 is comprised mostly of the Upper Granite Gorge and contains little habitat for juvenile fishes. As such, species richness was lower than in Reaches 3 and 4. This reach was sampled regularly only in the vicinity of Shinumo Creek and opportunistically at some other sites, such as near the mouth of Bright Angel Creek. Only 89 fish were captured in this reach, comprising 1.3% of the total catch. Fathead minnow still dominated the fish fauna, however, comprising 39.3% of the catch (Figure 17). Speckled dace (21.3%), flannelmouth sucker (14.6%) and rainbow trout (13.5%) are the remaining common species. Humpback chub (6.7%; mostly sub-adults) were also found here along with bluehead sucker (2.2%), common carp and brown trout (1.1%, each).

Most of the fish captured in Reach 5 were associated with tributary mouths. Bright Angel Creek and Shinumo Creek are the two largest tributaries, but several smaller ones (e.g., Clear Creek, Pipe Springs and Crystal Creek) also enter here. Brook trout and channel catfish have been reported incidentally from this area (Valdez and Ryel 1995).

Reach 6

A total of 331 fish (4.9%) were captured in Reach 6. Fathead minnow remained the dominant species, comprising 53.5% of the fishes captured in Reach 6 (Figure 17). Speckled dace (18.1%) and humpback chub (11.8%; mostly sub-adults and adults) were also commonly captured. Bluehead sucker (6.3%) and flannelmouth sucker (5.1%) were also found in this reach, as were rainbow trout (2.4%), plains killifish (1.5%) and red shiner (1.2%).

Reach 6 includes an area in the vicinity of Blacktail Canyon (RM 120.2) which contains some backwaters that appear to be very suitable for rearing of juvenile fishes. However, little use is made of them due to a lack of nearby spawning habitat for native fishes (AGFD 1996b). It also includes an area in the vicinity of Randy's Rock (RM 126.3) which contains a large aggregation of

adult humpback chub (Valdez and Ryel 1995). Channel catfish, common carp, brown trout and brook trout have also been captured here in the past (Valdez and Ryel 1995).

Reach 7

Kanab and Havasu creeks, two important spawning streams for bluehead and flannelmouth suckers, enter the Colorado River in Reach 7. A total of 1557 fish were captured in this reach, comprising 22.8% of the total 1996 catch. Fathead minnow remained the dominant species in this reach, as well, comprising 56.6% of the fish caught there (Figure 17). Flannelmouth sucker (17.6%), speckled dace (13.7%) and bluehead sucker (7.9%) were also commonly captured. A large number of other species were incidentally captured in this reach, including: rainbow trout (2.1%) and common carp, plains killifish, humpback chub, red shiner, brown trout, green sunfish and yellow bullhead (*A. natalis*), which comprised <1% each.

The presence of two important spawning tributaries increased the number of fish captured in this reach. Mainchannel water temperatures also increase with distance downstream from Glen Canyon Dam, enhancing survival of warmer water species (AGFD 1996b). Striped bass (*Morone saxatilis*) that migrated upstream from Lake Mead have been captured in this reach, as have brook trout and red shiner (Valdez and Ryel 1995; AGFD 1996b).

Reach 8

A total of 1,588 fish, comprising 23.3% of all fish captured in 1996, were captured in Reach 8. Speckled dace became the dominant species in this reach, comprising 58.4% of the total catch (Figure 17). Fathead minnow (27.0%), flannelmouth sucker (9.6%) and bluehead sucker (3.8%) were also common. Common carp, plains killifish, red shiner and green sunfish each comprised <1% of the total number caught.

Grand Canyon in Reach 8 is wide and often contains large, shallow backwaters that warm extensively in the summer (AGFD 1996b). Therefore, it is an important area for rearing of native fishes and some mainstem spawning may occur here, as well, since the mainchannel reaches temperatures as high as 18°C (AGFD 1996b). From 1991 - 1994 larval and juvenile bluehead and flannelmouth suckers were captured in large numbers in backwaters in Reach 8 (AGFD 1996b). These fish may have originated in Kanab and Havasu creeks or may have been spawned in the mainchannel. Also, 26 larval/juvenile humpback chub were captured in this reach between 1991 - 1994 (AGFD 1996b). The origin of these fish is unknown since it is possible that they drifted up to 140 miles downstream from the LCR. However, occasional captures of humpback chub in Havasu Creek and the occurrence of several small aggregations of adult humpback chub in this area suggest that they may have been spawned in a tributary or mainstem site in the lower part of Grand Canyon. Channel catfish, rainbow trout, striped bass and walleye (*Stizostedion vitreum vitreum*) have also been captured in this reach (Valdez and Ryel 1995; AGFD 1996b).

Tributaries

Tributaries of the Colorado River in Grand Canyon are the site of most fish spawning, particularly for the large native species. Therefore, the presence of non-native competitors/predators in tributaries can be detrimental or devastating to native fish populations. A lack of spring flooding in 1996 due to drought the previous winter may have been beneficial to small non-native species such as fathead minnow, plains killifish and red shiner in many tributaries of the Colorado River, Grand Canyon, in 1996. The Paria River is an important tributary in which both flannelmouth sucker and speckled dace spawn. This stream was sampled regularly in 1996, but the data are included in a separate report (Brouder and Hoffnagle 1997b), to which the reader is directed for information.

Little Colorado River

A total of 1,051 fish was captured in the LCR during Colorado River trips in 1996. Fathead minnow was the most common species captured, comprising 70.9% of the total number of fish (Figure 18). Other species commonly captured included bluehead sucker (6.1%), plains killifish (5.6%), flannelmouth sucker (5.4%), humpback chub (4.5%), common carp (4.5%) and red shiner (2.1%). Channel catfish, rainbow trout and speckled dace comprised <1%, each.

The LCR is the major spawning area for humpback chub and all four remaining native species also spawn there. It is also a common invasion site for non-native fishes. Plains killifish have been less common in the past and red shiner were only incidentally captured in the LCR in the past (Robinson et al. 1996). However, a lack of spring flooding in the LCR, due to a drought in the winter of 1995/96 may have improved conditions for the non-native fathead minnow, plains killifish and red shiner and allowed their numbers to increase dramatically. Brown trout have also been captured in the LCR (Marsh and Douglas 1997). The LCR was sampled opportunistically during each river trip in 1996 with mini-hoop nets and by seining. However, our effort was not intensive and the reader is directed to Brouder and Hoffnagle (1997a) for a more thorough discussion of the LCR fish assemblage during AGFD spring monitoring.

Shinumo Creek

A total of 233 fish was captured in Shinumo Creek in 1996. Fathead minnow (44.6%) and speckled dace (30.0%) were the most commonly captured species (Figure 18). Bluehead sucker (12.0%) and flannelmouth sucker (10.3%) were also common and humpback chub (1.7%) and rainbow trout (1.3%) were also captured.

A waterfall approximately 50 m upstream from its mouth, is a barrier to upstream fish movement and reduces the value of Shinumo Creek as a spawning tributary for native fishes. Additionally, the presence of brown trout (AGFD 1996b) and rainbow trout increase the amount of predation on small fishes in this part of the stream. However, flannelmouth and bluehead suckers spawn here, there is a small aggregation of adult/sub-adult humpback chub in the vicinity and juvenile chub have been captured in Shinumo Creek (Valdez and Ryel 1995; AGFD

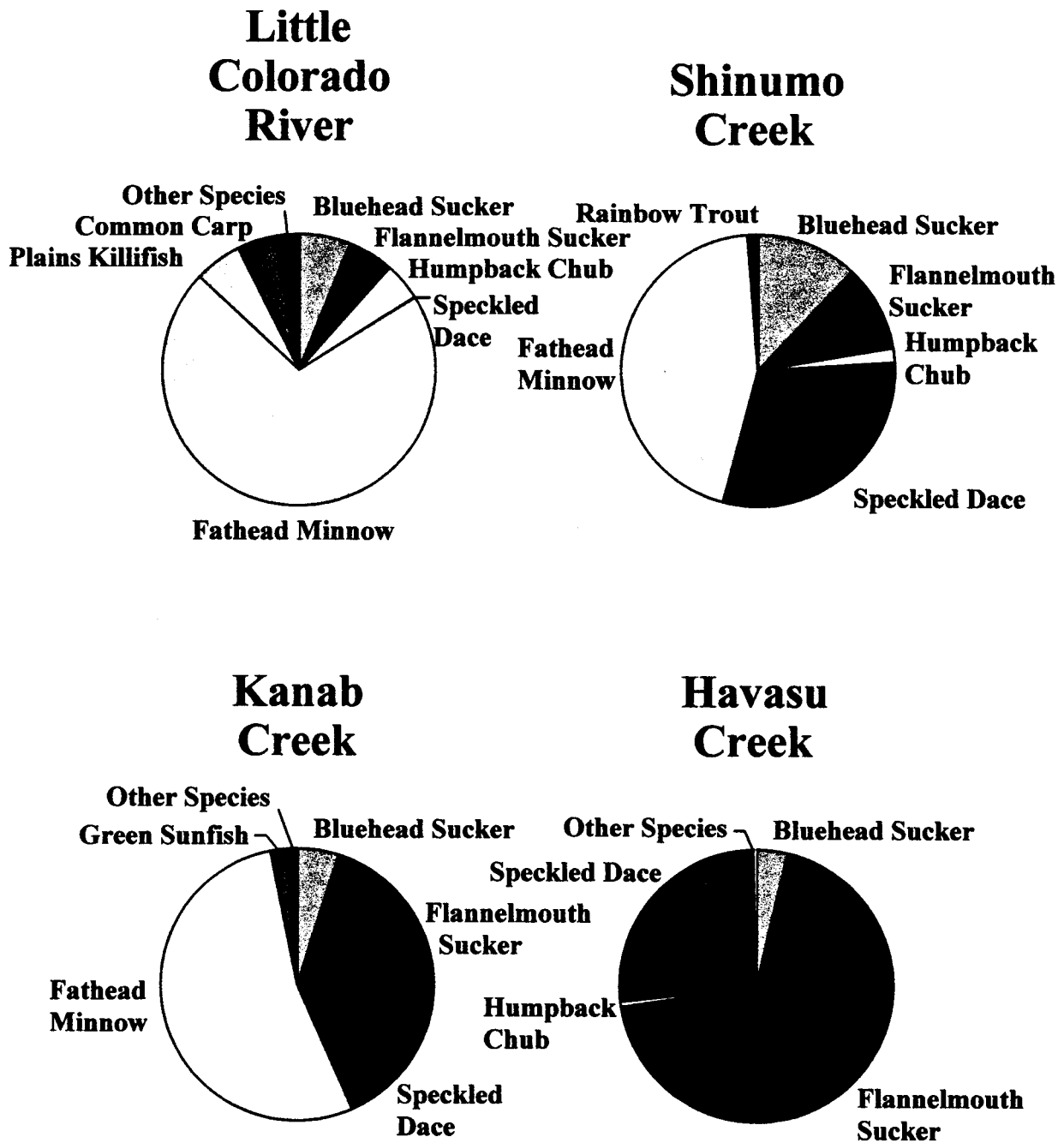


Figure 18. Species composition of the total catch in each sampled tributary during AGFD Monitoring in the Colorado River, Grand Canyon, 1996.

1996b). Plains killifish, brook trout and common carp have also been caught in lower Shinumo Creek (Valdez and Ryel 1995; AGFD 1996b). Above the waterfall, only resident populations of speckled dace and bluehead sucker are found (AGFD 1996b).

Kanab Creek

We captured 628 fish in Kanab Creek and fathead minnow (53.5%) was the most common species (Figure 18). Flannelmouth sucker (29.6%), speckled dace (8.8%) and bluehead sucker (4.9%) were also common. Green sunfish (1.9%), rainbow trout (0.8%), plains killifish (0.3%) and common carp (0.2%) were also captured.

Kanab Creek is a small, low velocity (3 cfs base flow) stream that is an important spawning area for native suckers. The invasion of Kanab Creek by green sunfish in 1995 may be an important event that reduces survival of larval suckers in Kanab Creek (Tuegel et al. 1995). Since then, green sunfish have been captured regularly and they have reproduced (Hoffnagle and Persons 1996). However, large numbers of bluehead and flannelmouth suckers continue to spawn in Kanab Creek and spring and monsoon flooding may keep numbers of green sunfish sufficiently depressed. Striped bass, brown trout and channel catfish have also been captured in Kanab Creek (AGFD 1996b).

Havasu Creek

A total of 327 fish was captured in Havasu Creek in 1996. Flannelmouth sucker (68.8%) was most common, with speckled dace (26.3%) and bluehead sucker (3.7%) also being common (Figure 18). Two humpback chub (0.6%) and one (0.3%) each of fathead minnow and rainbow trout were also captured in the mouth of Havasu Creek.

Havasu Creek, similar to Shinumo Creek, has a series of waterfalls approximately 100 m from its mouth which block upstream fish movement. Resident bluehead sucker and speckled dace are the only species found above this cataract. Below this area, flannelmouth sucker and bluehead sucker spawn on gravel bars. Their larvae drift into the mainstem Colorado River soon after hatching and may be some of the YOY we capture in backwaters in Reach 8. Adult humpback chub have been sporadically captured in the mouth of Havasu Creek and in its vicinity in the Colorado River (Valdez and Ryel 1995; AGFD 1996b). At least one humpback chub has been a ripe male, indicating that some spawning by humpback chub may occur here. Common carp, striped bass and brook trout have also been captured here (Valdez and Ryel 1995; AGFD 1996b).

Species Distribution

Distribution of native fishes in Grand Canyon is linked to known or suspected spawning tributaries (Figure 19), as was previously documented by AGFD (1996b). Non-native fish

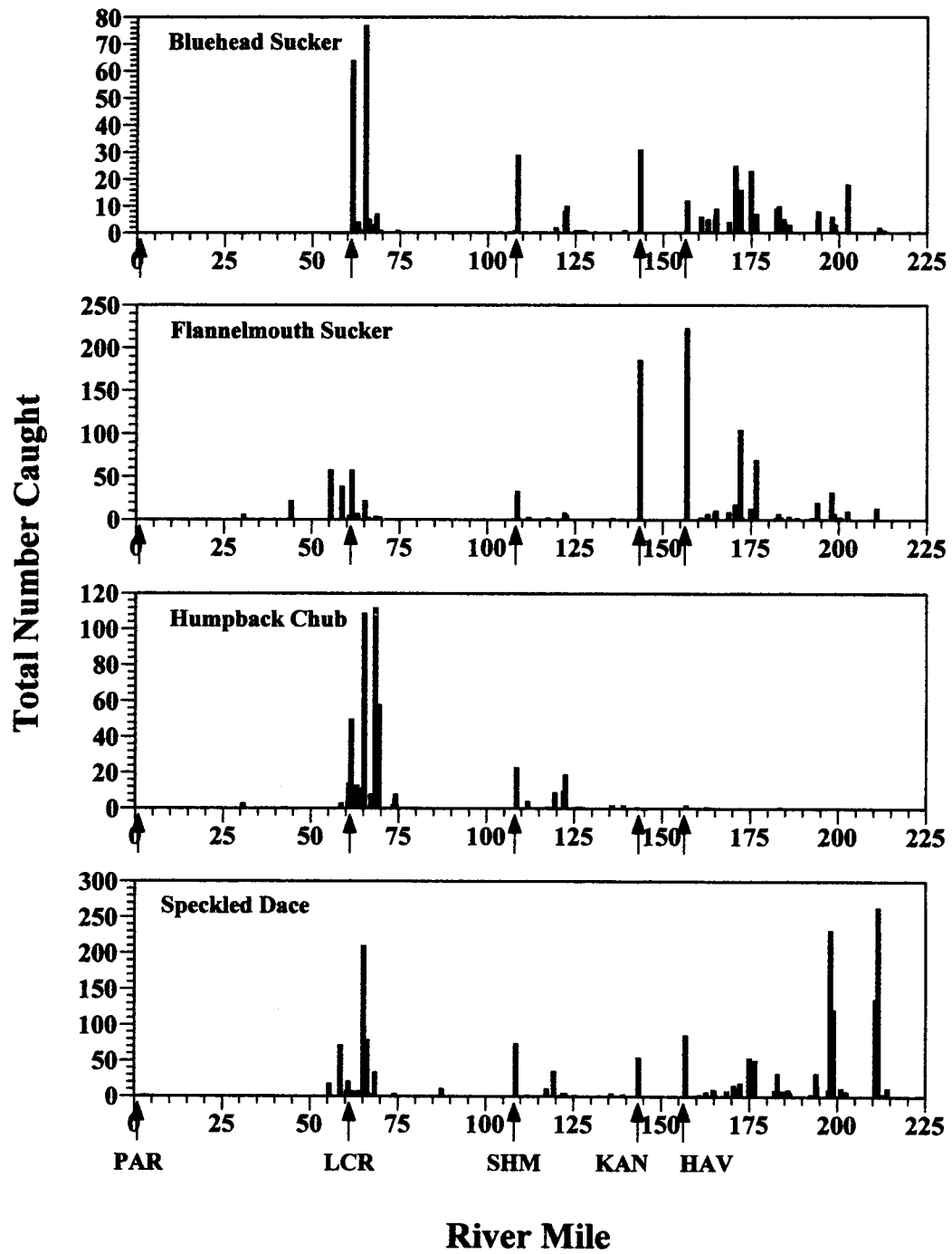


Figure 19. Number of each native species caught in the Colorado River and tributaries, Grand Canyon, Arizona, during AGFD Monitoring trips, 1996. Major spawning tributaries are noted by arrows: PAR = Paria River, LCR = Little Colorado River, SHM = Shinumo Creek, KAN = Kanab Creek, HAV = Havasas Creek.

distributions are also linked to warm tributaries (Figure 20). Some non-native species have not extensively expanded their ranges in Grand Canyon and are still most common in the tributary through which they probably invaded - e.g., LCR (plains killifish) or Kanab Creek (green sunfish). Other non-native fishes, e.g., fathead minnow, rainbow trout and common carp, are more widespread in Grand Canyon.

Bluehead Sucker

Bluehead sucker was captured in all reaches below the LCR (Reaches 3 - 8). This species comprised from 7.9% (123 fish) of the catch in Reach 7 and 7.7% (89 fish) of the catch in Reach 3 to 1.4% (22 fish) in Reach 4 (Figures 17 and 21). Bluehead sucker have been caught in Reach 2, but mostly in the lower portion of that reach, immediately above the LCR (Valdez and Ryel 1995; AGFD 1996b).

Bluehead sucker were also captured in all four tributaries sampled (Figures 18 and 22) and are known to spawn in each of them (AGFD 1996b). They comprised as little as 3.7% (12 fish) of the catch in Havasu Creek and as much as 12% (28 fish) of the catch in Shinumo Creek. Bluehead sucker have rarely been observed above the LCR (AGFD 1996b), but were found in the Paria River in February 1997 (Brouder and Hoffnagle 1997d). Bluehead sucker also spawn in most of the smaller tributaries in Grand Canyon (AGFD 1996b), but these were not sampled in 1996.

Flannemouth Sucker

Flannemouth sucker was found in all mainstem reaches, except Reach 1, where little effort was expended. Flannemouth sucker comprised 28.3% (141 fish) of the catch in Reach 2 where they are suspected of spawning in warm springs below RM 30 (Figures 17 and 21). They were also commonly captured in Reaches 7, 5 and 8 where they comprised 17.6% (274 fish), 14.6% (13 fish) and 9.6% (152 fish) of the catches, respectively. Larval and juvenile flannemouth suckers are commonly captured with larval and juvenile bluehead suckers in backwaters below spawning tributaries. They exhibit considerable diet overlap and appear to occupy very similar niches for their first year of life (AGFD 1996b).

Flannemouth sucker was also caught in all four sampled tributaries and is known to spawn in all of them (Figures 18 and 22). They were most commonly captured in Havasu Creek, where they comprised 68.8% (225 fish) of the catch, but were also common in Kanab (29.6%; 186 fish) and Shinumo (10.3%; 24 fish) creeks. Flannemouth sucker comprised only 5.4% (57 fish) of the catch in the LCR. Flannemouth sucker also spawn in the Paria River as has been heavily documented in recent years (Weiss 1993; AGFD 1996b; Brouder and Hoffnagle 1997b; d; Thieme 1998).

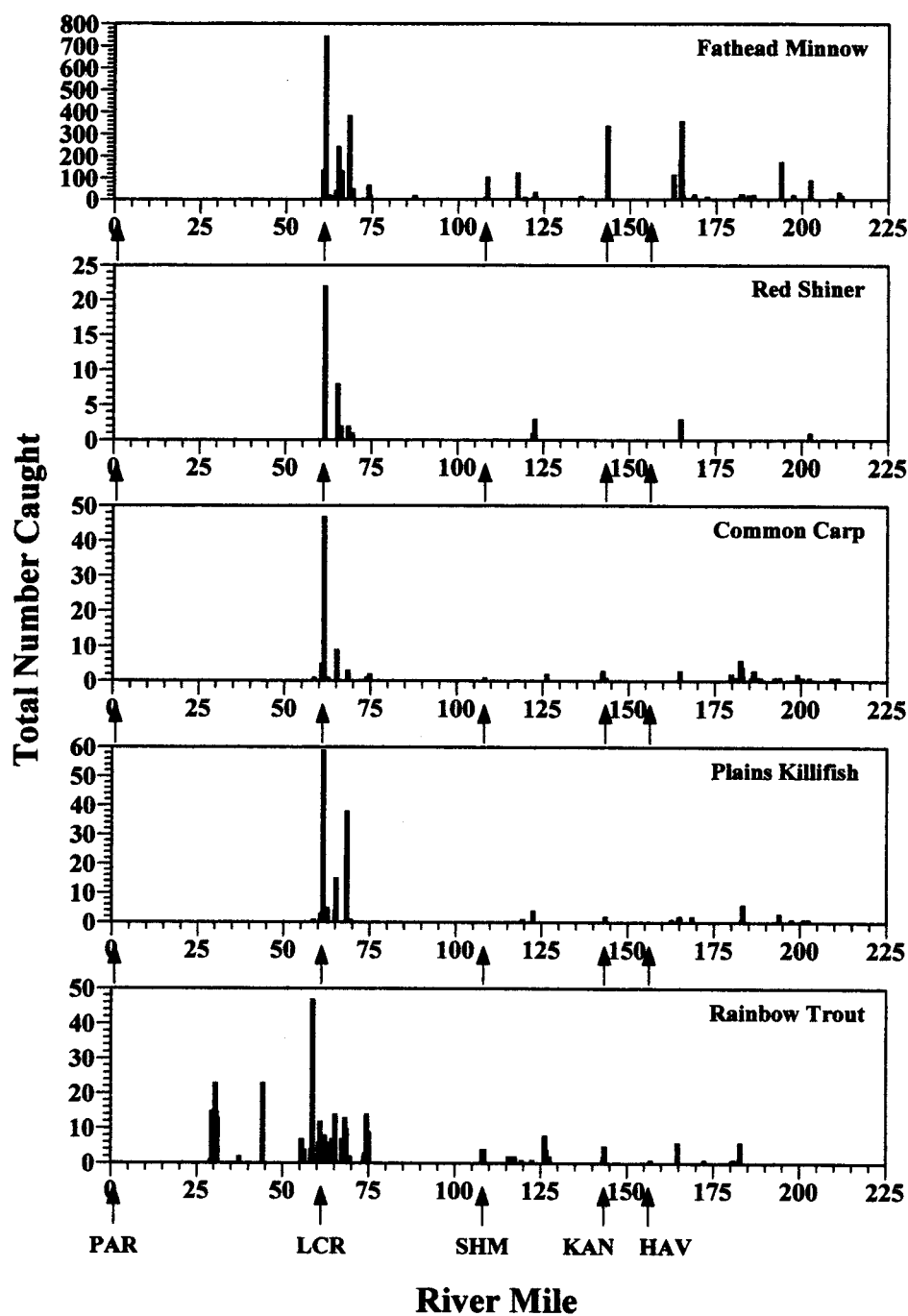


Figure 20. Number of each non-native species caught in the Colorado River and tributaries, Grand Canyon, Arizona, during AGFD Monitoring trips, 1996. Major spawning tributaries are noted by arrows: PAR = Paria River, LCR = Little Colorado River, SHM = Shinumo Creek, KAN = Kanab Creek, HAV = Havasus Creek.

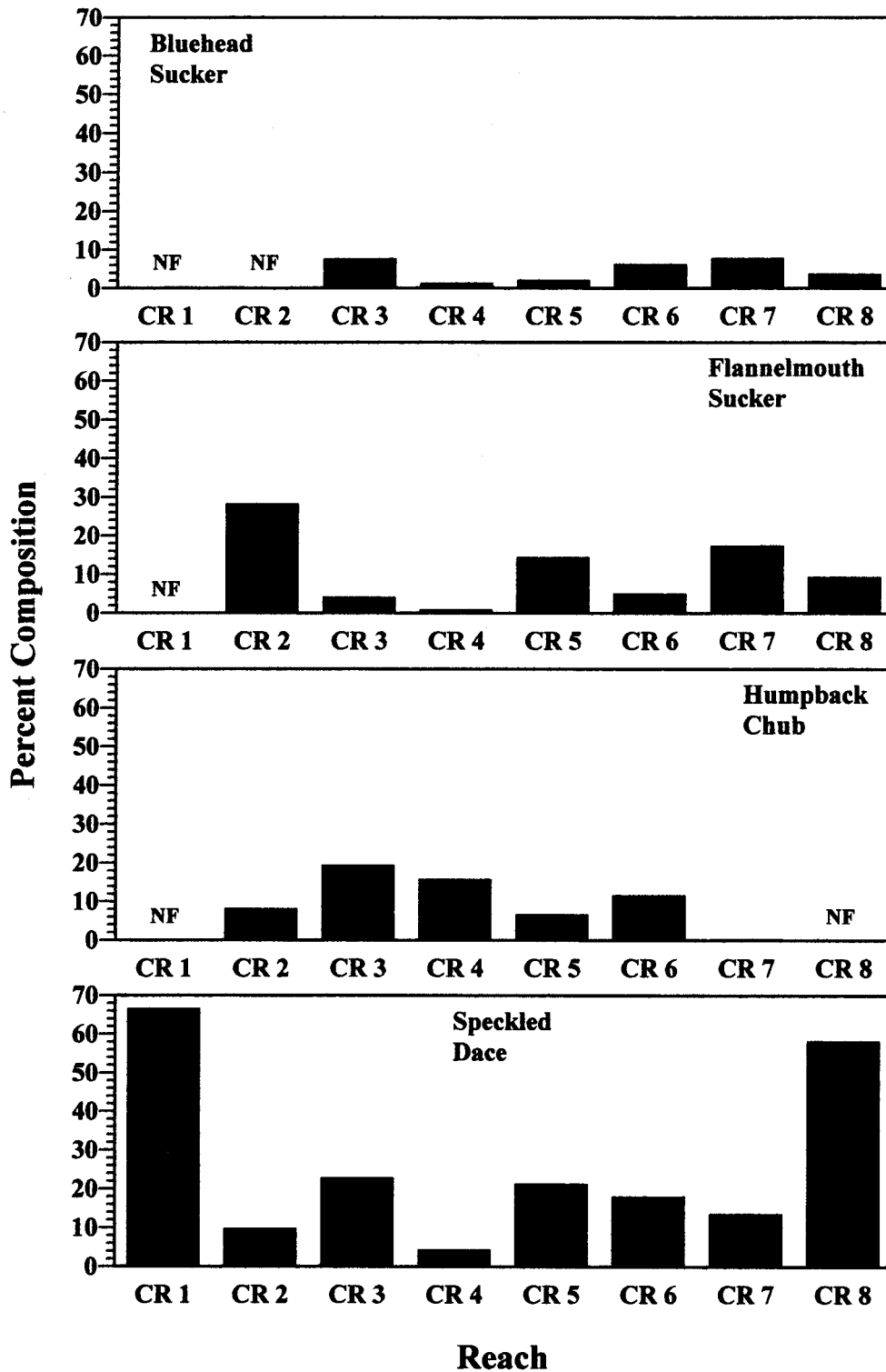


Figure 21. Percent of the total catch in each reach comprised by each native species during AGFD Monitoring in the Colorado River, Grand Canyon, 1996. NF = no fish captured.

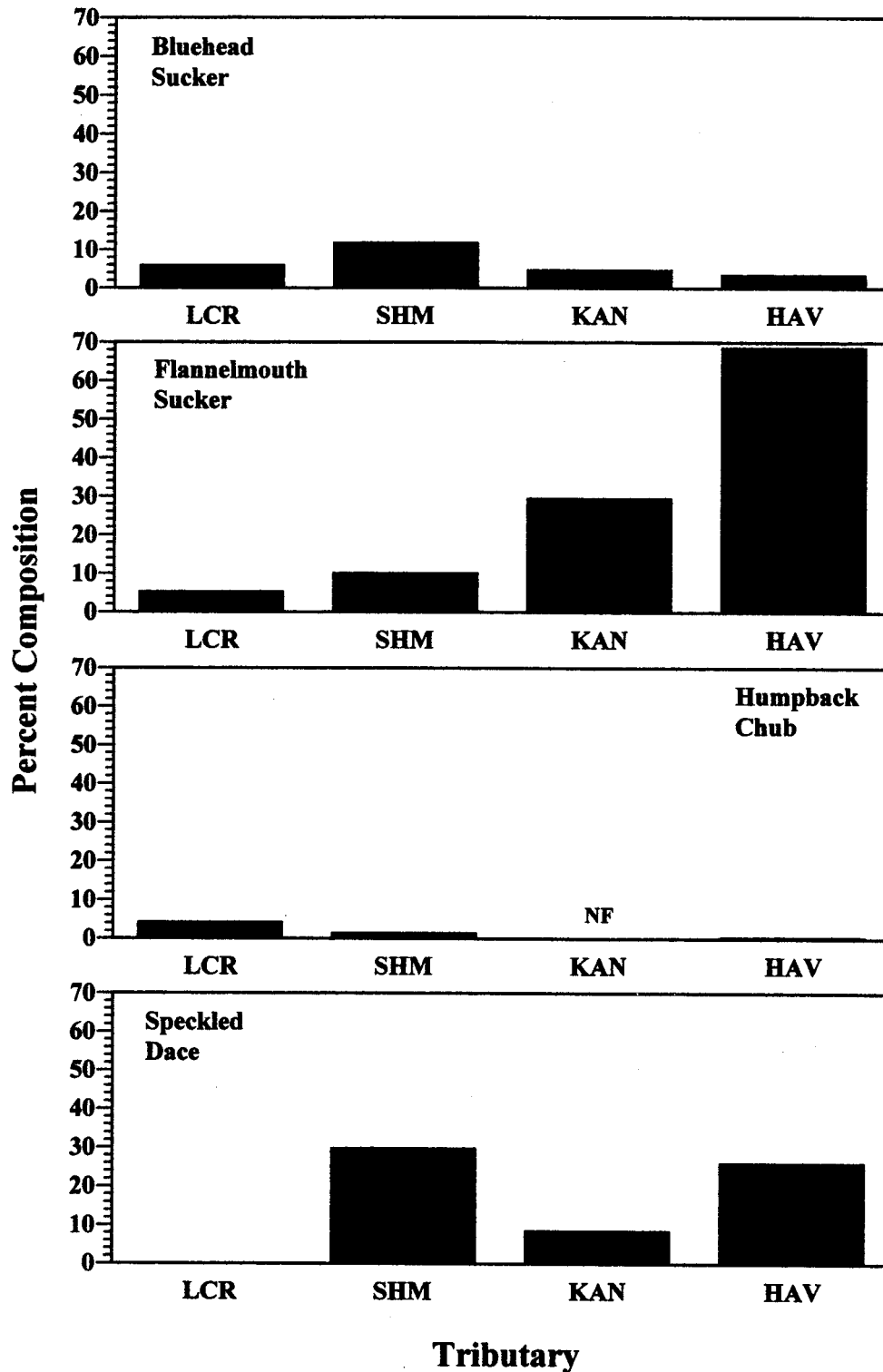


Figure 22. Percent of the total catch in each sampled tributary comprised by each native species during AGFD Monitoring in the Colorado River, Grand Canyon, 1996. NF = no fish captured.

Humpback Chub

Humpback chub were captured in Reaches 2 - 7 (Figures 17 and 21). They were most common in Reaches 3 and 4, where they comprised 19.5% (225 fish) and 15.8% (253 fish) of the catches, respectively. Humpback chub also comprised 11.8% (39 fish) of the catch in Reach 6.

Humpback chub were also captured in three of the four sampled tributaries (Figures 18 and 22). They comprised 4.5% (47 fish) of the catch in the LCR, 1.7% (4 fish) in Shinumo Creek and 0.6% (2 fish) in Havasu Creek.

Humpback chub are rarely caught in Reach 1, but are locally abundant in most other reaches (Valdez and Ryel 1995; AGFD 1996b). Juvenile humpback chub have been captured below many known or suspected spawning areas, including the warm springs below RM 30 and the LCR (Valdez and Ryel 1995; AGFD 1996b). Very small (<20 mm) humpback chub have also been captured in Reach 8, indicating the possibility of successful spawning somewhere in the lower canyon, but the site has not been found (AGFD 1996b). Captures of adult humpback chub in the mouth of Havasu Creek lend credence to the hypothesis that they may be spawning in that tributary. However, the area of warm springs below Lava Falls Rapid (RM 179.5) is another potential spawning location.

Speckled Dace

Speckled dace were common throughout Grand Canyon (Figures 17 and 21). Their prevalence ranged from 66.7% (2 fish) in Reach 1 and 58.4% (927 fish) in Reach 8 to 4.4% (71 fish) in Reach 4.

Speckled dace were also captured in all four sampled tributaries (Figures 18 and 22). They comprised from 30.0% (70 fish) in Shinumo Creek to 0.1% (1 fish) in the LCR.

Speckled dace are the most ubiquitous species in Grand Canyon (Valdez and Ryel 1995; AGFD 1996b). They are found in all mainstem reaches and in all tributaries, even many that are ephemeral (AGFD 1996b; Brouder and Hoffnagle 1997b; c; d).

Common Carp

Common carp were found in all reaches, except Reaches 1 and 6 (Figures 17 and 23). They were not commonly caught in any reach, comprising <1% of the total catch in only Reach 5 (1 fish). As many as 11 fish were caught in Reach 8 where they comprised 0.7% of the catch.

Common carp were found in the LCR and Kanab Creek (Figures 18 and 24). They comprised 4.5% (47 fish) of the catch in the LCR and 0.2% (1 fish) in Kanab Creek.

Common carp are found throughout Grand Canyon and their prevalence increases with distance downstream from Glen Canyon Dam (Valdez and Ryel 1995). Adults are commonly found in the LCR (AGFD 1994), but 1996 has been unusual, with the frequent capture of YOY. Carp are potential competitors of native fishes and a common host of the Asian fish tapeworm (Hoffman and Schubert 1984; Clarkson et al. 1997).

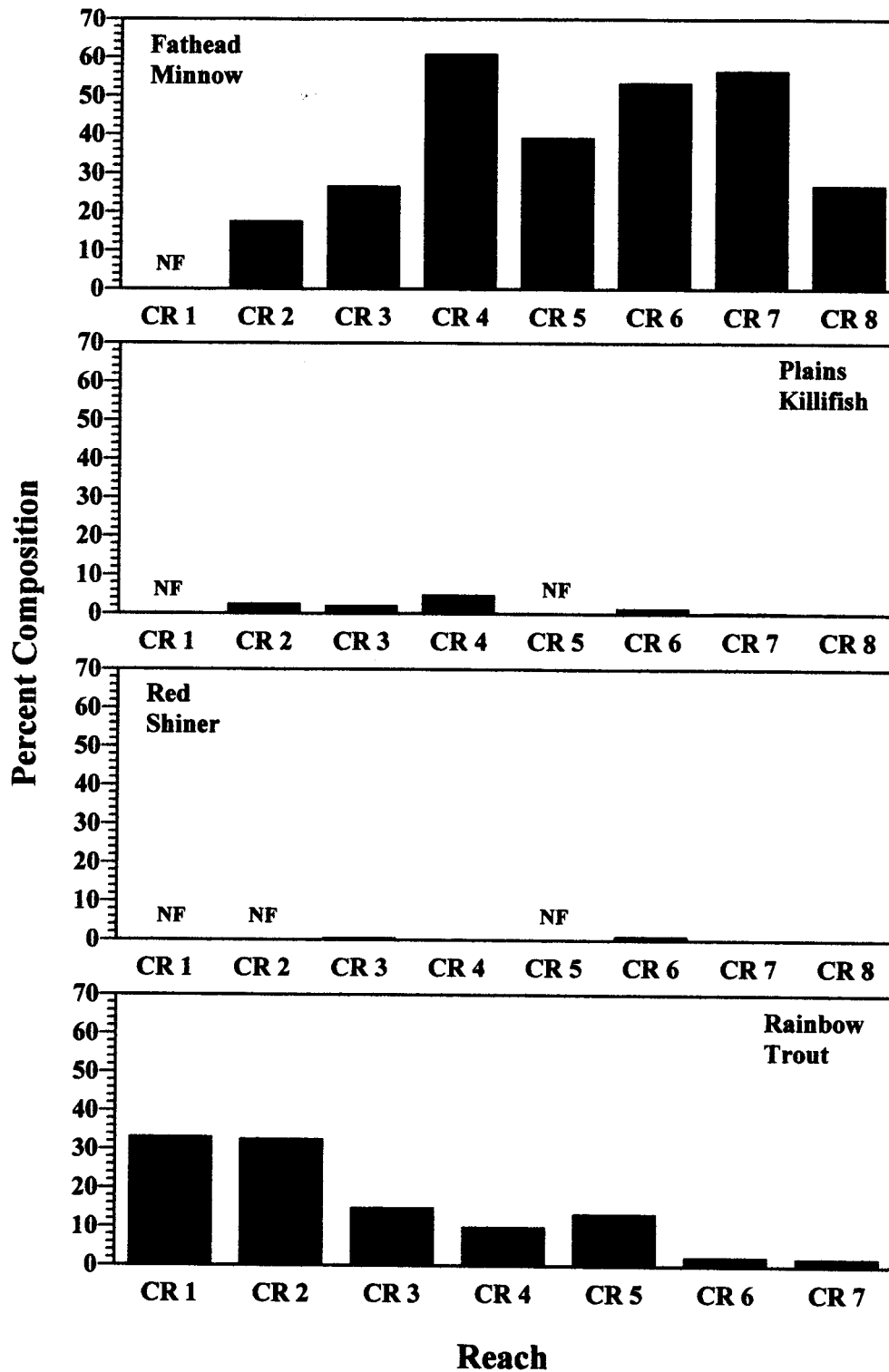


Figure 23. Percent of the total catch in each reach comprised by common non-native species during AGFD Monitoring in the Colorado River, Grand Canyon, 1996. NF = no fish captured.

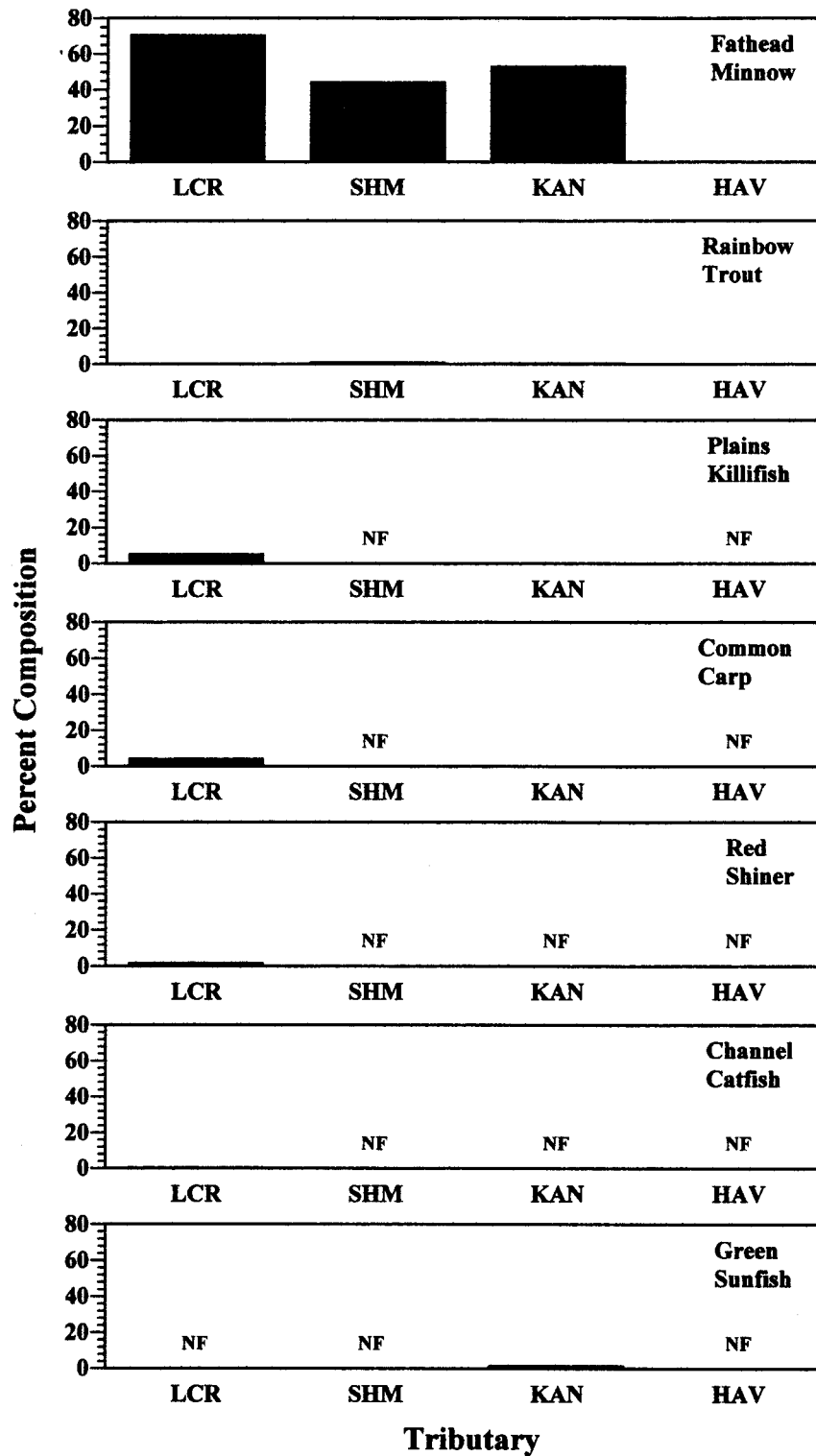


Figure 24. Percent of the total catch in each sampled tributary comprised by non-native species during AGFD Monitoring in the Colorado River, Grand Canyon, 1996. NF = no fish captured.

Fathead Minnow

Fathead minnow was caught in all reaches, except Reach 1 (Figures 17 and 23) and was the most common species captured, overall. They comprised 45.1% of the total catch (4,082 fish) and $\geq 17.7\%$ of the catch in all reaches, exceeding 50% of the catch in Reaches 4, 6 and 7.

Fathead minnow was also caught in all sampled tributaries (Figures 18 and 24). Only one fish (0.3%) was caught in Havasu Creek. However, fathead minnow comprised 70.9% (745 fish) of the catch in the LCR, 53.5% (336 fish) in Kanab Creek and 44.6% (104 fish) in Shinumo Creek.

Fathead minnow is now the most common fish in Grand Canyon. Fathead minnow likely invaded Grand Canyon from the upper LCR drainage where they are also common (J. Novy, AGFD, personal communication). They are not strong swimmers and have not expanded their range in the mainstem Colorado River very far upstream from the LCR. However, they have dispersed extensively downstream. They are now abundant throughout the mainstem Colorado River and most perennial tributaries below a point just above the LCR (AGFD 1996b). They are also known hosts of the Asian fish tapeworm (Hoffman and Schubert 1984; Brouder and Hoffnagle 1997c; Clarkson et al. 1997).

Red Shiner

Red shiner was captured in Reaches 3, 4, 6, 7, and 8 (Figure 23). They were not common in any reach, however, with their prevalence ranging from 0.1% (1 fish) in Reach 8 to 1.2% (4 fish) in Reach 6. As many as eight fish (0.7%) were caught in Reach 3.

The only tributary in which red shiners were caught was the LCR (Figure 24). Here, they comprised 2.1% (22 fish) of the total catch.

Red shiner is common in the lowest part of Grand Canyon (upper Lake Mead), below Separation Rapid (RM 239.6), but have been only sporadically reported from the Colorado River and tributaries above Diamond Creek (Valdez and Ryel 1995). This species may have benefitted from the 1995/96 drought which may have allowed an above average spawn and recruitment in the LCR. They were first captured this year on the June trip (10 fish). Thirty-three fish were captured in September (including one in Reach 8) when they were flushed out of the LCR by a small monsoon spate. However, this flood was not large enough to deplete the population, since more fish were captured in the LCR in the spring of 1997 (AGFD, unpublished data). The establishment of red shiners in the LCR may be detrimental to native fishes since it is a predator of larval fishes (Ruppert et al. 1993; Rice et al. 1997) and adults are competitors with juvenile native species (Minckley 1973; Sigler and Sigler 1996). Although they may be detrimental to native fishes in tributaries, it is unlikely that red shiners will colonize the mainstem Colorado River above Lake Mead since they avoid clear, cool water (Pflieger 1975). Their avoidance of the mainstem Colorado River may help prevent them from colonizing other tributaries, such as Kanab Creek

where they could prey on larval bluehead and flannelmouth suckers. Red shiner is also a host of the Asian fish tapeworm, which heavily infects humpback chub (Hoffman and Schubert 1984).

Plains Killifish

Plains killifish were found in all reaches, except Reaches 1 and 5 (Figures 17 and 23). They were most commonly captured in Reach 4, where they comprised 4.9% (79 fish) of the total catch. In Reaches 7 and 8, they comprised only 0.5% (8 fish) and 0.4% (6 fish) of the total catch.

Plains killifish were found in the LCR and Kanab Creek (Figures 18 and 24). They comprised 5.6% (59 fish) of the catch in the LCR and only 0.3% (2 fish) in Kanab Creek.

Plains killifish have been extending their range and increasing in number in Grand Canyon since the early 1990's (AGFD 1996b). This species probably also invaded Grand Canyon from the upper LCR drainage, where they are found (J. Novy, AGFD, personal communication). As with fathead minnows, they are not strong swimmers and are only found in the lower portion of Reach 2. This species is a potential competitor of native fishes, since they prey upon similar items in Grand Canyon (AGFD 1996b). Plains killifish is also another host of the Asian fish tapeworm (Brouder and Hoffnagle 1997c; Clarkson et al 1997).

Rainbow Trout

Rainbow trout were captured in all reaches, except Reach 8 (Figures 17 and 23). They were most common above the LCR, where they comprised 33.3% (1 fish) and 32.7% (163 fish) of the catches in Reaches 1 and 2, respectively. Below the LCR, their prevalence ranged from 13.5% (12 fish) in Reach 5 to 2.1% (33 fish) in Reach 7.

Rainbow trout were also caught in all sampled tributaries, but in low numbers (Figures 18 and 24). As few as one fish was caught in the LCR (0.1%) and Havasu Creek (0.3%) and as many as five fish (0.8%) were caught in Kanab Creek. Rainbow trout comprised 1.3% (3 fish) of the total catch in Shinumo Creek.

Rainbow trout spawn in the mainstem Colorado River above the LCR and in many tributaries, including ephemeral tributaries throughout Grand Canyon (AGFD 1996b). They are most common in the colder and, perhaps more importantly, clearer waters above the LCR. The fish in Reach 5 were associated with Shinumo Creek, in which they spawn. Rainbow trout were dispersed downstream by the flood (Hoffnagle et al. *In review*), increasing their prevalence in the lower reaches. Rainbow trout are predators of small fishes in the LCR (Marsh and Douglas 1997) and predation by rainbow trout on native fishes in the in the mainstem Colorado River may be significant (Valdez and Ryel 1995).

Other Species

Six other species were captured during 1996 (Table 1). None of these fish comprised >2% of the catch in any reach or tributary and two of the species were very rare.

The most interesting catch may have been that of a flannelmouth sucker x razorback sucker (*Xyrauchen texanus*) hybrid. This fish was 612 mm TL, weighed 2135 g and had a definitive, but reduced, dorsal keel. It was captured in the LCR side channel during the experimental flood and had been previously PIT-tagged, although we could not find the original marking data.

The other unusual capture was that of a redbreasted shiner (*Richardsonius balteatus*). This fish was 53 mm TL and weighed 1.1 g. It was captured at RM 63.70 during the low 8,000 cfs flows following the experimental flood.

Brown trout were caught in Reaches 3, 4, 5 and 7. They were uncommon in all areas and were not caught in any of the tributaries. They comprised from 1.1% (1 fish) of the catch in Reach 5 to 0.1% (1 fish) in Reach 7. As many as six fish (0.4%) were caught in Reach 4. Brown trout have been caught in Shinumo and Bright Angel Creeks, in which they spawn, and in the mouth of Kanab Creek (Otis 1994; AGFD 1996b). Brown trout were also caught in the LCR and had consumed speckled dace (Marsh and Douglas 1997). Valdez and Ryel (1995) considered brown trout to be the most effective predator of native fishes in Grand Canyon.

Channel catfish were captured only in the LCR (Figure 24). Eight fish were caught, comprising 0.8% of the total catch. Channel catfish have also been captured in the mainstem Colorado River and in the mouth of Kanab Creek (Valdez and Ryel 1995; AGFD 1996b). They are another potential predator of native fishes. Channel catfish in the LCR were found to consume all four remaining native species (Marsh and Douglas 1997).

Green sunfish were found in Kanab Creek and in Reaches 7 and 8. Only three fish (0.1% of the catch in each reach) were captured in the mainstem, while 12 fish (1.9%) were caught in Kanab Creek (Figure 24). Green sunfish are piscivorous and have a large gape for their size, enabling them to consume relatively large prey items (Pflieger 1975). Their invasion of Kanab Creek is likely to be detrimental to the bluehead and flannelmouth suckers that spawn there.

One yellow bullhead was captured, comprising 0.1% of the catch, in Reach 7. Yellow bullheads are sporadically captured throughout Grand Canyon below the LCR (Valdez and Ryel 1995).

Length Frequency Analyses

Young-of-the-year and adults of all native species were collected (Figures 25 - 28; Appendix 16). However, sub-adult bluehead sucker, flannelmouth sucker and humpback chub were rarely collected, lending concern for recruitment into the adult populations of these species. All life history stages of all commonly captured non-native species were present (Figures 29 - 33).

Bluehead Sucker

Age 1 bluehead suckers (20 - 69 mm) were common in the catch along with adults (180 - 309 mm) on Trip 96-1 (Figure 25). Fewer bluehead suckers were captured on Trip 96-3, with sizes ranging from 20 - 369 mm. Young-of-the-year appeared on Trip 96-4, after drifting out of

spawning tributaries, as 10 - 39 mm fish and age 1 fish continued to be captured (30 - 89 mm). On Trip 96-5, the majority of fish ranged from 20 - 109 mm (YOY and age 1 fish) with a few sub-adults (140 - 159 mm) and adults (190 - 339 mm).

Flannemouth Sucker

Two groups of flannemouth sucker were captured on Trip 96-1 (Figure 26): 20 - 129 mm fish (comprising age 1 and probably some age 2 fish) and 290 - 589 mm fish (spawning adults that were mostly captured in the mouths of Kanab and Havasu creeks). On Trip 96-3 nearly all fish captured were adults or sub-adults (170 - 529 mm) in spawning tributaries. Only ten other fish were captured (20 - 109 mm). Conversely, on Trip 96-4, nearly all flannemouth suckers caught were YOY and age 1 fish (10 - 89 mm). By Trip 96-5, YOY and age 1 fish (10 - 129 mm) still dominated the catch, but fewer numbers were caught. Sub-adults and adults were also caught, up to 579 mm.

Humpback Chub

Estimating age of humpback chub can be difficult due to the fact that some fish stay in the warmer LCR where they can grow quickly, while others disperse or are displaced into the colder mainstem Colorado River, where they initially grow slower (Clarkson and Lupher 1994). However, since food may be more plentiful in the mainstem, as fish become large enough to withstand the current, growth may be quicker than in the LCR.

On Trip 96-1, age 1 (20 - 69 mm) and adult (310 - 469 mm) humpback chub were most commonly captured (Figure 27). The same pattern was evident on Trip 96-3, although fewer fish were caught. On Trip 96-4, though, age 1 fish (20 - 159 mm), possibly with some YOY's and age 2 fish dominated the catch, with only six larger fish being captured. On Trip 96-5, seasonal flooding in the LCR displaced large numbers of YOY and age 1 (30 - 149 mm) humpback chub into the mainstem Colorado River. However, since capture of sub-adult (150 - 250 mm) humpback chub is rare, it appears that survival is low.

Speckled Dace

Speckled dace is a small species that matures within a year and has a life span of 2 - 3 years (Minckley 1991). On Trip 96-1, age 1 fish dominated the catch with a modal length class of 3 cm. A few older fish were also captured (Figure 28). By Trip 96-3, these fish had increased in size to a modal length class of 4 cm. On Trip 96-4, YOY dominated the catch, ranging from 10 - 39 mm. Age 1 fish (40 - 89 mm; modal length class=5 cm) were still captured in numbers similar to the previous trips. On Trip 96-5, fewer age 1 fish were caught and the YOY's had reached a modal length class of 4 cm.

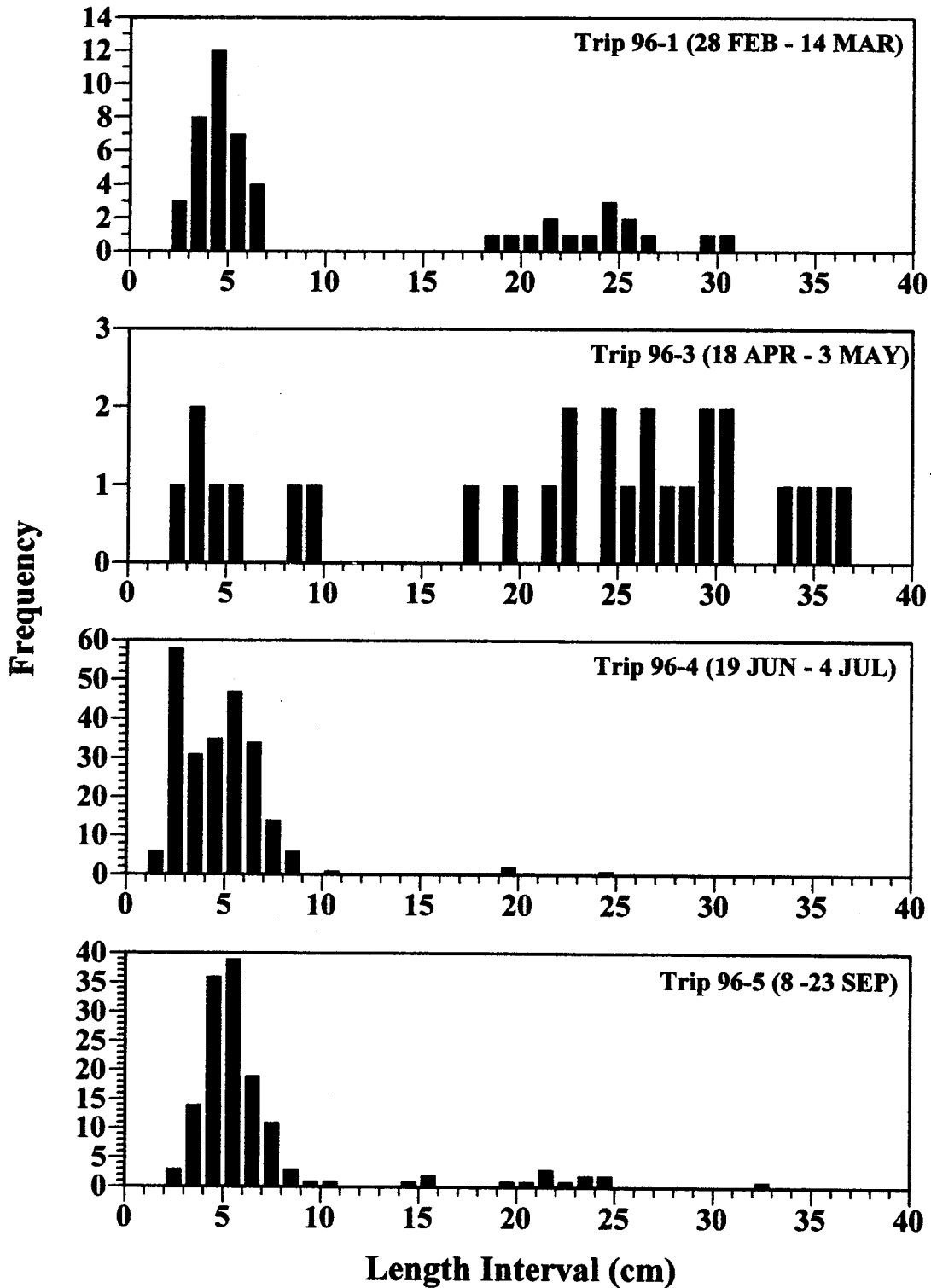


Figure 25. Bluehead sucker length frequencies during AGFD Monitoring Trips 96-1, 96-3, 96-4 and 96-5 in the Colorado River and tributaries, Grand Canyon, Arizona, 1996.

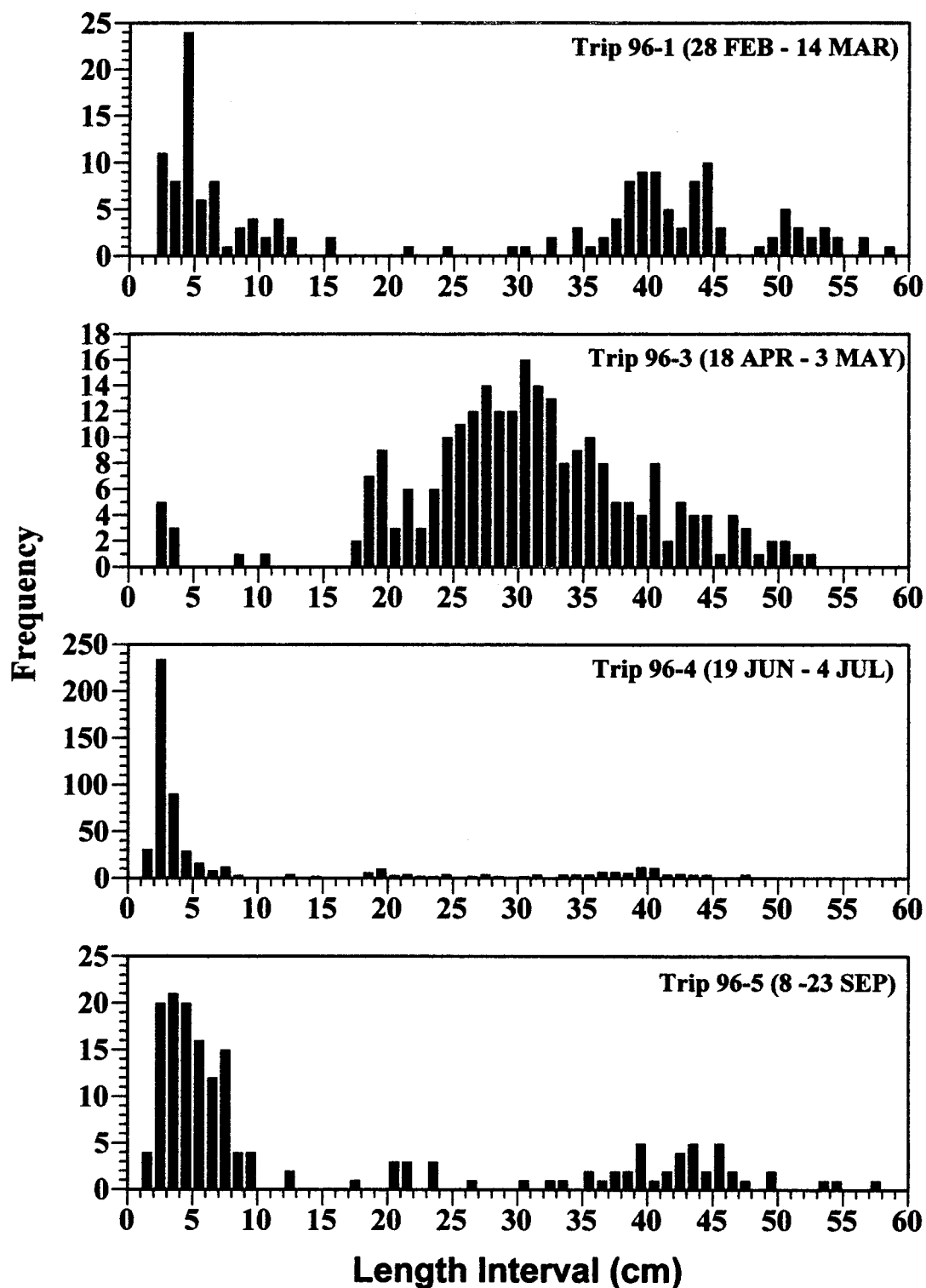


Figure 26. Flannelmouth sucker length frequencies during AGFD Monitoring Trips 96-1, 96-3, 96-4 and 96-5 in the Colorado River and tributaries, Grand Canyon, Arizona, 1996.

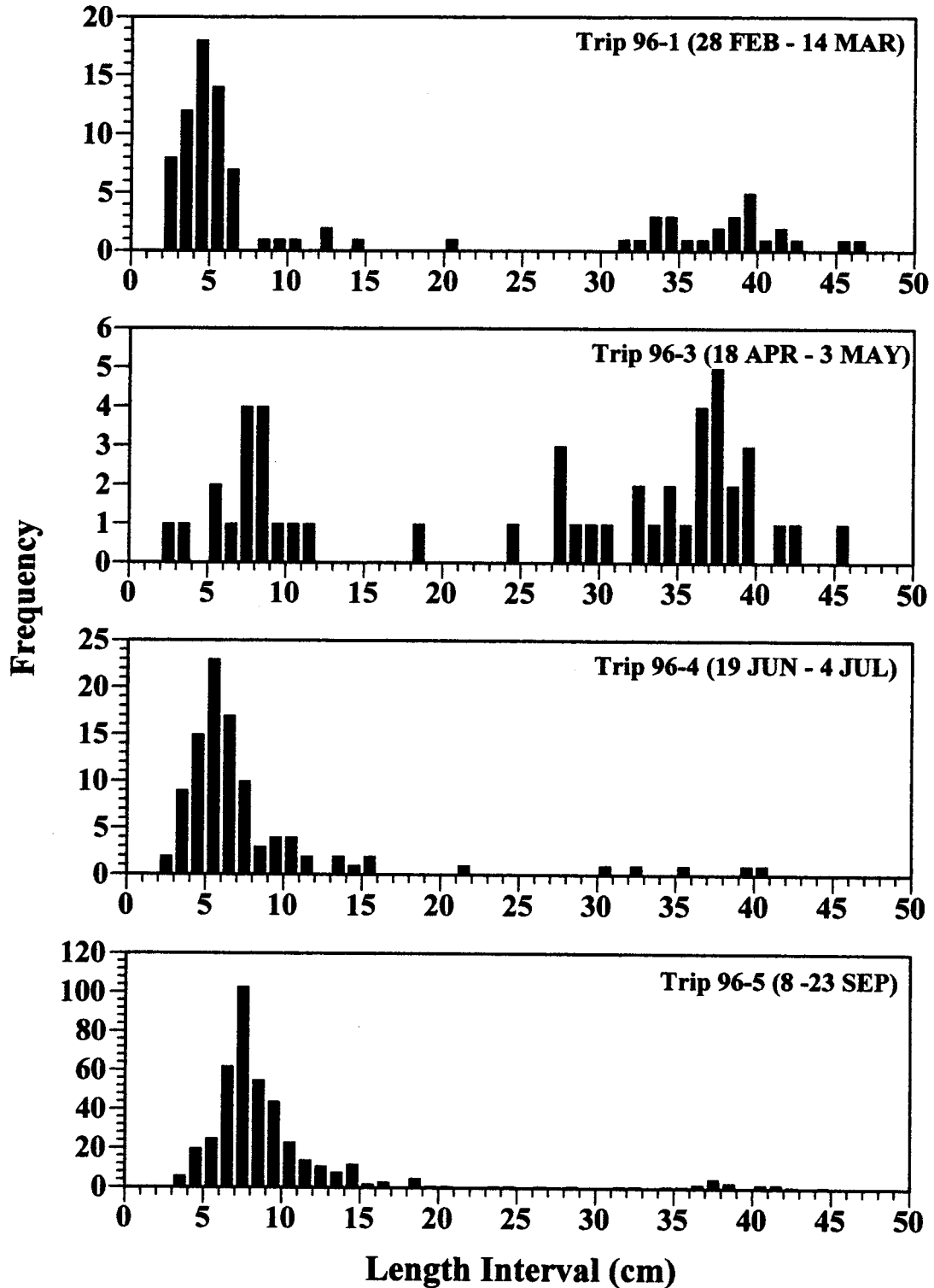


Figure 27. Humpback chub length frequencies during AGFD Monitoring Trips 96-1, 96-3, 96-4 and 96-5 in the Colorado River and tributaries, Grand Canyon, Arizona, 1996.

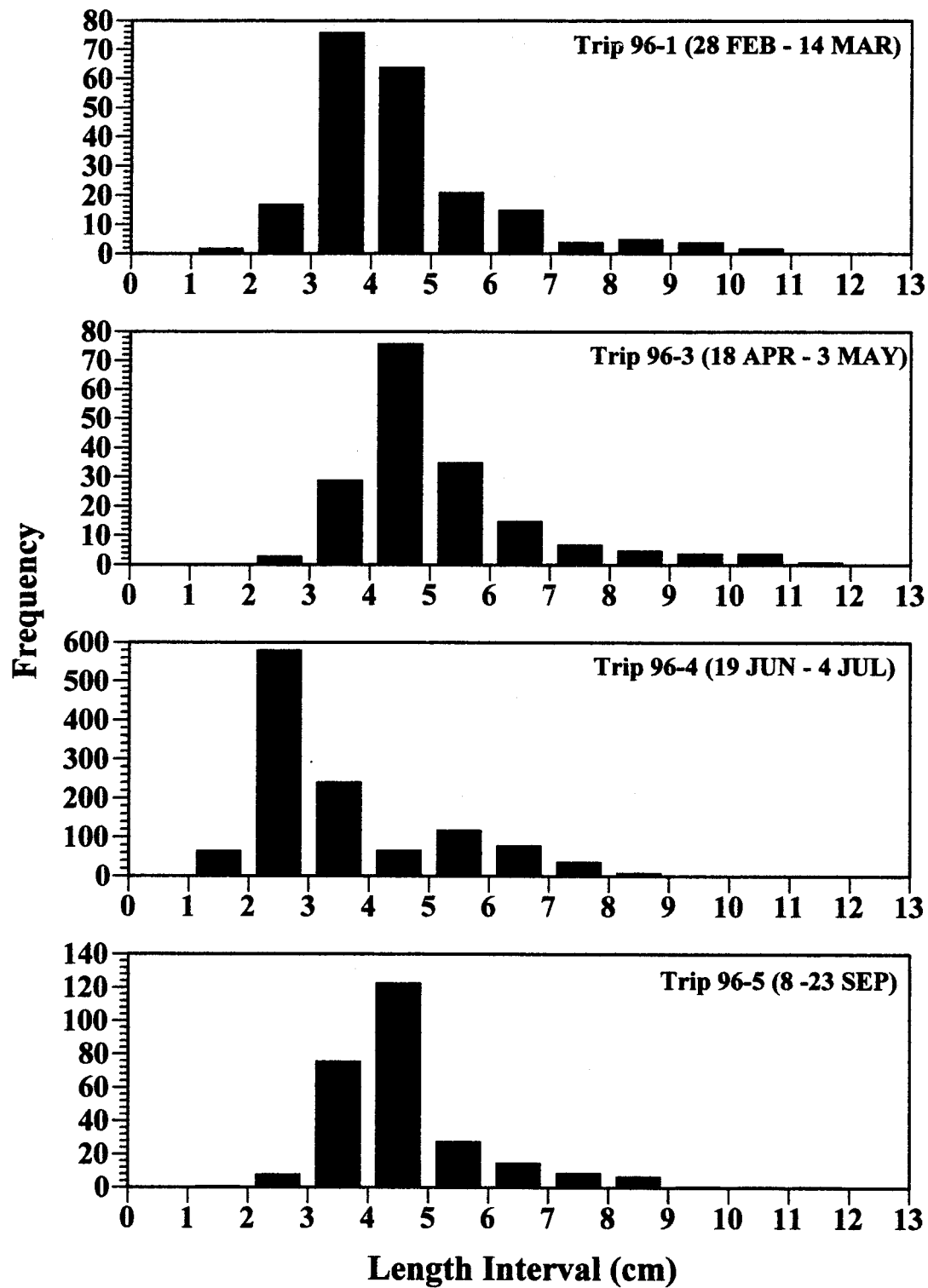


Figure 28. Speckled dace length frequencies during AGFD Monitoring Trips 96-1, 96-3, 96-4 and 96-5 in the Colorado River and tributaries, Grand Canyon, Arizona, 1996.

Common Carp

Common carp were caught infrequently on Trip 96-1 (Figure 29). Ten carp were captured ranging from 70 - 159 mm and another five ranged from 410 - 579 mm. Only seven carp (300 - 649 mm) were caught on Trip 96-3. Probable age 1 carp (20 - 79 mm) were the dominant group caught on Trip 96-4, with nine other fish (180 - 669 mm) also being caught. Only eleven common carp (50 - 229 mm) were captured on Trip 96-5.

Fathead Minnow

The fathead minnow is a small, short-lived and highly prolific species (Carlander 1969; Scott and Crossman 1973). They were commonly caught on Trip 96-1, with most being age 1 fish (modal length class = 4 cm; Figure 30). Fewer fathead minnows were caught on Trip 96-3, a result of the experimental flood (Hoffnagle 1996; Hoffnagle et al. *In review*) but the size distribution remained similar to that of Trip 96-1. On Trip 96-4, similar numbers of age 1 fish (modal length class = 5 cm) were caught, but YOY (modal length class = 2 cm) appeared in large numbers. By Trip 96-5 the YOY had grown, with a modal length class of 4 - 5 cm. These fish were probably mature (Carlander 1969; Scott and Crossman 1973) and could have been the parents of the smaller fish caught on this trip.

Plains Killifish

Plains killifish have been becoming increasingly common in recent years (AGFD 1996b) and are now regularly caught in low numbers. On Trip 96-1, 49 fish were caught, ranging in size from 20 - 79 mm and with a modal length class of 3 cm (Figure 31). The experimental flood decimated their numbers (AGFD 1996a) and none were captured on Trip 96-3. However, the plains killifish population in the mainstem Colorado River rebounded quickly. By Trip 96-4, 51 YOY (10 - 39 mm) and one adult were captured. On Trip 96-5, the YOY had reached a modal length class of 3 cm and we observed and captured large numbers of plains killifish in backwaters. The source of the reinvading killifish was probably tributaries (most of which did not flood due to a drought in 1996). Upon reaching the mainstem Colorado River, these fish were probably further benefitted by relatively low daily fluctuations throughout the remainder of the 1996.

Rainbow Trout

Subadult and adult rainbow trout (160 - 479 mm) were commonly captured on Trip 96-1 with only three other fish (20 - 49 mm) being caught (Figure 32). After the experimental flood (Trip 96-3), similar numbers of subadults and adults (210 - 439 mm) were captured, but nearly 50 YOY (20 - 79 mm) were caught. These fry, some having just absorbed their yolk sac, were probably displaced from upstream spawning areas, possibly as far as Glen Canyon, above Lees Ferry (AGFD 1996a). On Trip 96-4, adults (250 - 429 mm) remained common, while fewer YOY (now 30 - 119 mm) were caught. By Trip 96-5, adults (270 - 449 mm) remained common

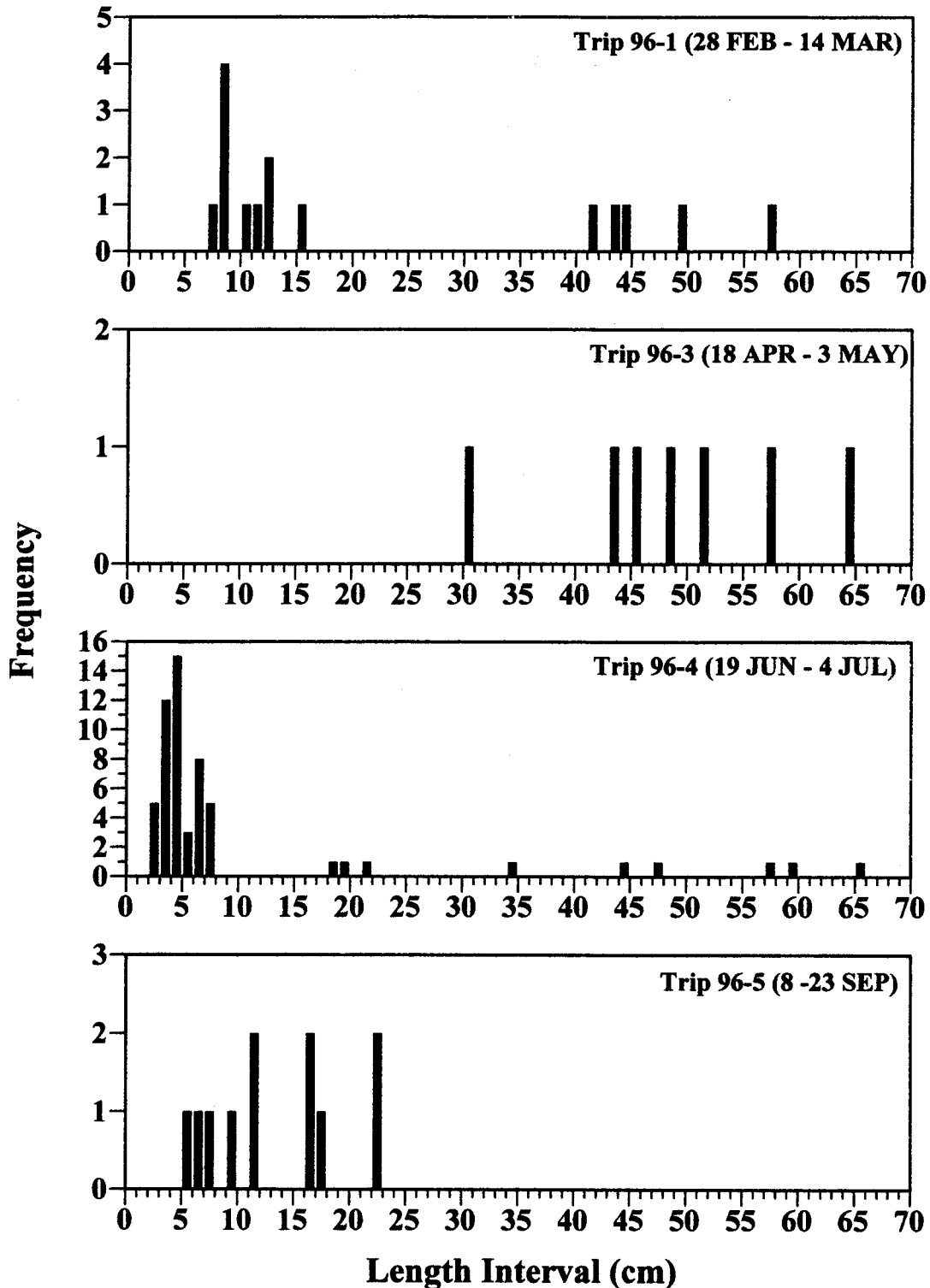


Figure 29. Common carp length frequencies during AGFD Monitoring Trips 96-1, 96-3, 96-4 and 96-5 in the Colorado River and tributaries, Grand Canyon, Arizona, 1996.

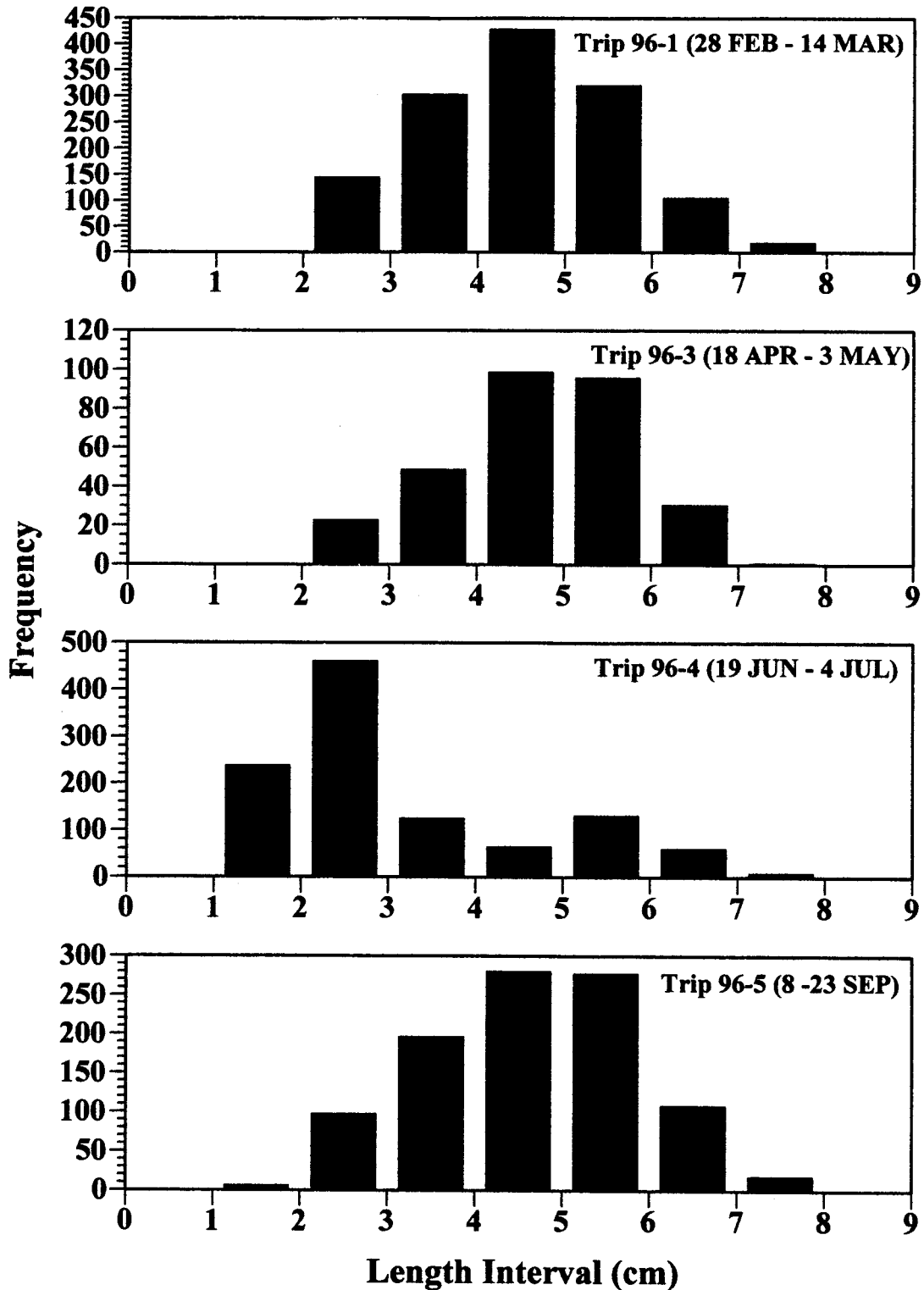


Figure 30. Fathead minnow length frequencies during AGFD Monitoring Trips 96-1, 96-3, 96-4 and 96-5 in the Colorado River and tributaries, Grand Canyon, Arizona, 1996.

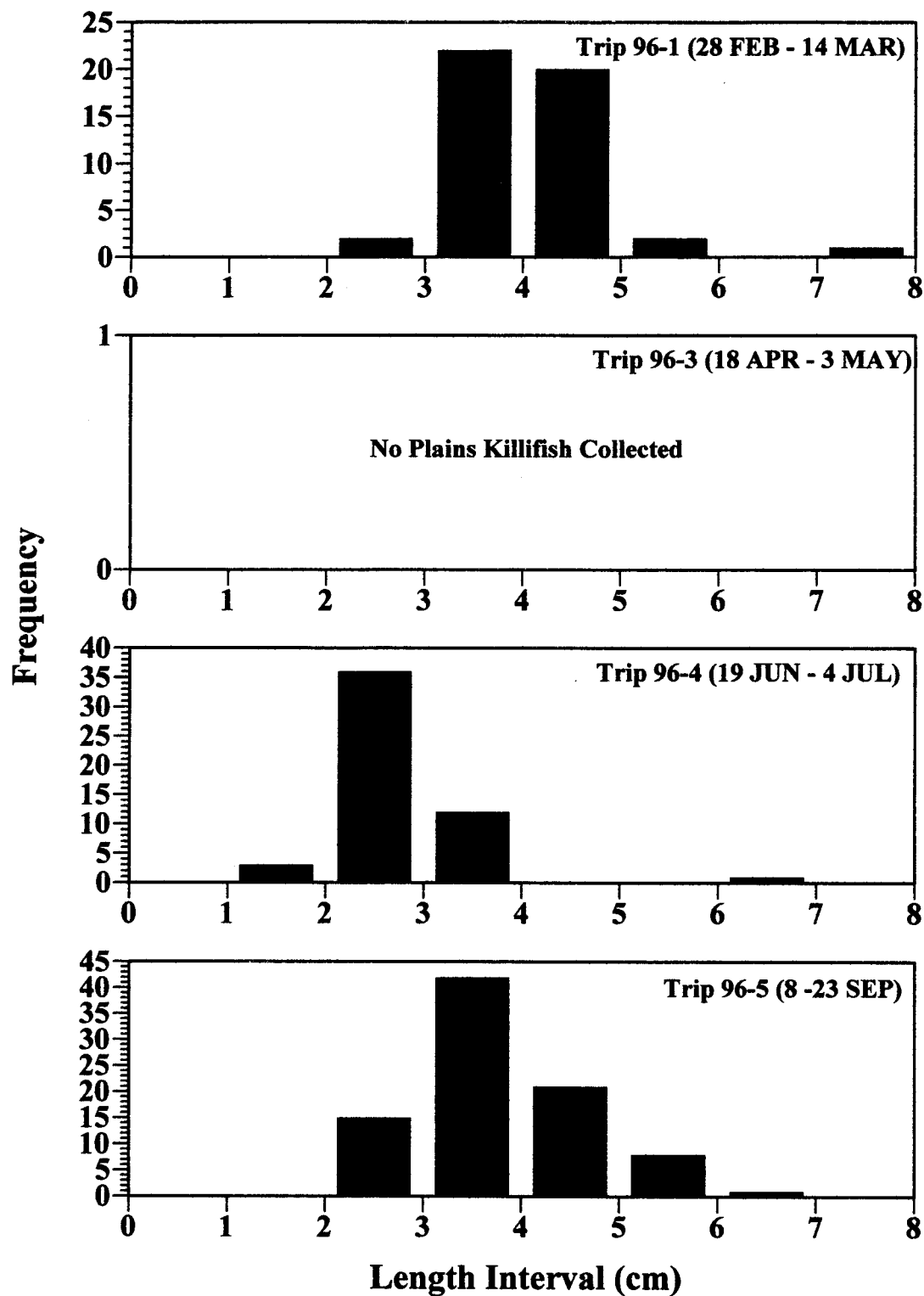


Figure 31. Plains killifish length frequencies during AGFD Monitoring Trips 96-1, 96-3, 96-4 and 96-5 in the Colorado River and tributaries, Grand Canyon, Arizona, 1996.

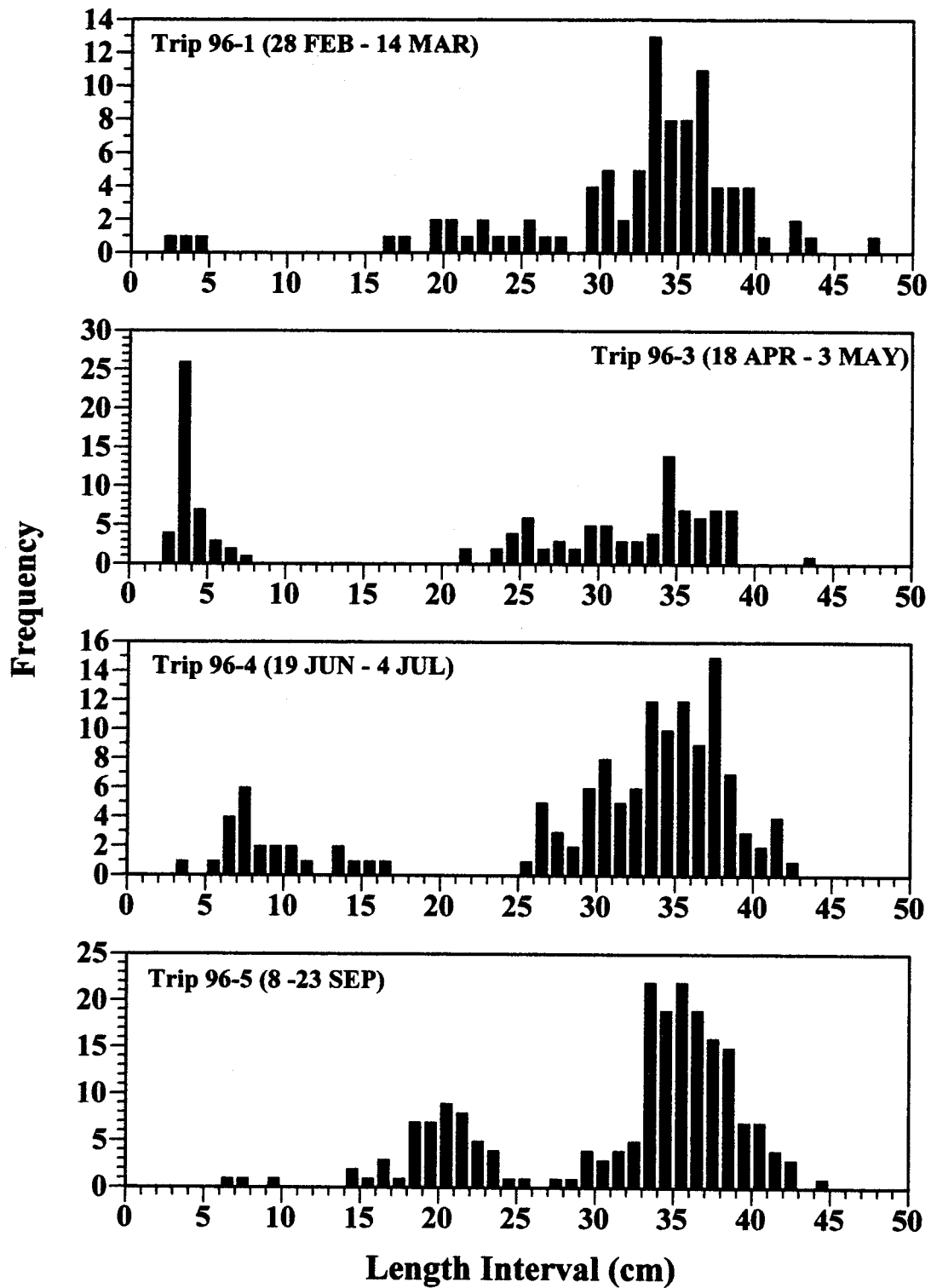


Figure 32. Rainbow trout length frequencies during AGFD Monitoring Trips 96-1, 96-3, 96-4 and 96-5 in the Colorado River and tributaries, Grand Canyon, Arizona, 1996.

and the YOY had grown considerably (modal length class = 20 cm). This growth of approximately 10cm in three months seems high but is possible (J. Niccum, AGFD, personal communication) with the high productivity seen in the river in 1996 (Blinn et al. *In review*; McKinney et al. *In review*).

Red Shiner

Red shiner were not captured until Trip 96-4, when 10 age 1 fish (36 - 52 mm) were captured (Figure 33). On Trip 96-5 an additional 33 red shiner, including some YOY, were caught, ranging in length from 22 - 66 mm.

As for other non-native species, red shiner probably also benefitted from the lack of flooding in tributaries in 1996. Red shiner have been occasionally captured in LCR (AGFD, unpublished data), but it seems like spring and monsoon flooding have kept their numbers low. Small monsoon floods in the LCR in 1996 flushed some of them into the mainstem and as far downstream as Reach 8.

PIT Tagging

A total of 667 native fishes >150 mm was caught and checked for the presence of a PIT tag: 151 fish (22.6%) were previously tagged (recaptured) and 516 (77.4%) were implanted with PIT tags in 1996 (Table 3). Forty-eight bluehead suckers (153 - 344 mm) were captured, none of which were recaptured fish. A total of 520 flannelmouth suckers was caught (173 - 582 mm). We marked 441 (84.8%) flannelmouth suckers and 79 (15.2%) were previously tagged. Ninety-nine humpback chub (150 - 460 mm) were caught: 27 (27.2%) marks and 72 (72.8%) recaptures. One coded-wire tagged rainbow trout (335 mm) was captured. Appendix 17 gives the size at capture and date and location of capture for each fish marked with a PIT tag during 1996. Appendix 18 provides the size at last capture and date and location of last and previous captures (if available) for all fish recaptured in 1996.

We were able to find original mark information of 44 recaptured flannelmouth sucker and 59 recaptured humpback chub (Table 4). The flannelmouth suckers were at-large for a mean of 692 days (0 - 1730 days) and gained a mean of 105.8 mm TL (-8 - 338 mm) and 344.9 g (-37 - 877g). These fish grew at a mean rate of 4.8 mm and 14.1g / 30 days. Mean distance between capture sites was 40.2 river miles and ranged from 0 - 161.65. These results agree with those of Weiss (1993), Valdez and Ryel (1995), AGFD (1996b) and Thieme (1998) who reported that flannelmouth suckers move great distances. Some of these movements may be related to spawning, while others may relate to feeding or other wanderings of this species.

Fifty-nine recaptured humpback chub were at-large for a mean of 1363 days (0 - 2190 days). They gained a mean of 24.0 mm TL (-8 - 200 mm) and 103.7 g (-74 - 418 g), rates of 0.47 mm and 2.63 g / 30 days. Mean distance between capture sites was 2.04 miles (0 - 29.82). Humpback chub, in contrast to flannelmouth sucker, is a sedentary species, often spending their

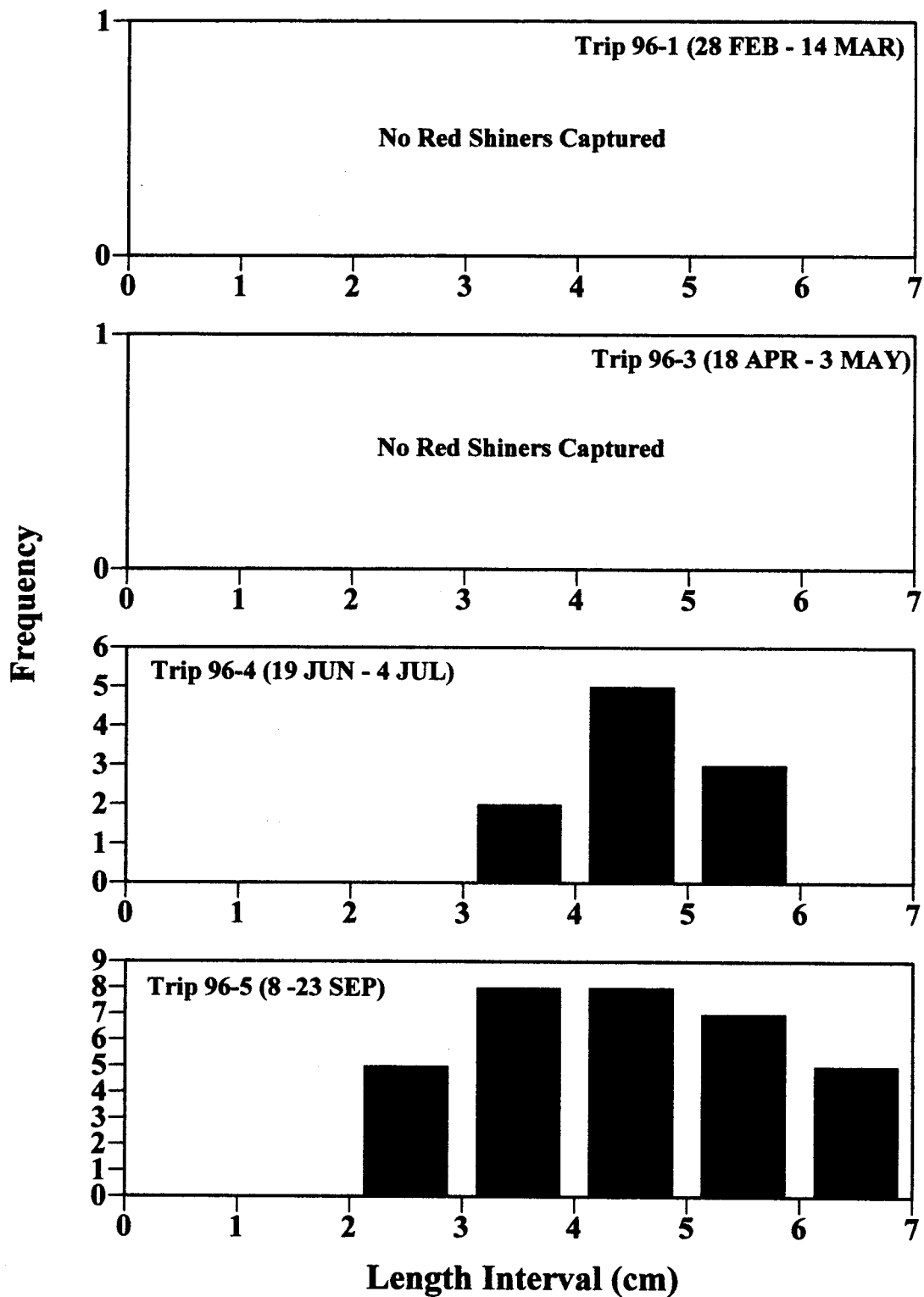


Figure 33. Red shiner length frequencies during AGFD Monitoring Trips 96-1, 96-3, 96-4 and 96-5 in the Colorado River and tributaries, Grand Canyon, Arizona, 1996.

Table 3. Number of fish implanted with a PIT tag, recaptured [PIT tag or coded wire tag (rainbow trout)] and mean and range of total lengths and weights of tagged fish from the Colorado River and tributaries, Grand Canyon, Arizona, during AGFD monitoring trips, 1996.

Species	Number Marked	Number Recaptured	Total Length (mm)		Weight (g)	
			Mean	Range	Mean	Range
Bluehead Sucker	48	0	240.5	153-344	165.40	29.8-542
Flannelmouth Sucker	441	79	345.0	173-582	491.04	9-2069
Humpback Chub	27	72	334.7	150-460	422.56	30.8-1141
Rainbow Trout	-	1	335	-	352	-

Table 4. Mean and range of days at-large, changes in length and weight, rate of changes in length (mm / 30 days at large) and weight (g / 30 days at-large) and distance (river miles) between captures sites for 44 flannelmouth sucker and 59 humpback chub recaptured during AGFD monitoring in the Colorado River and tributaries, Grand Canyon, 1996.

Variable	Flannelmouth Sucker		Humpback Chub	
	Mean	Range	Mean	Range
Days At-Large	692	0 - 1730	1363	0 - 2190
Change in Length (mm)	105.8	-1 - 338	24.0	-8 - 200
Change in Weight (g)	344.9	-1 - 877	103.7	-74 - 418
Rate of Change in Length (mm / 30 days)	4.79	-0.02 - 9.01	0.47	-0.19 - 3.24
Rate of Change in Weight (g / 30 days)	14.15	-0.50 - 33.82	2.63	-1.87 - 24.30
Distance Between Capture Sites	40.2	0 - 161.65	2.04	0 - 29.82

entire lives (except for spawning migrations) within a mile or two of river (Valdez and Ryel 1995). This was confirmed by observations of radio-tagged humpback chub during the experimental flood (Valdez and Hoffnagle *In review*). Movement by these humpback chub was largely due to spawning migrations into the Little Colorado River.

Humpback Chub Health

Health indices of 21 and 34 juvenile (YOY and age 1) humpback chub were examined from the LCR and mainstem Colorado River, respectively. Young humpback chub from the mainstem Colorado River appeared to be healthier than those from the LCR: by both condition and by parasite load.

Juvenile humpback chub sampled in the mainstem Colorado River were significantly longer ($P=0.0177$), heavier ($P=0.0019$) and had a greater mean condition factor (K ; $P=0.0044$) than those from the LCR. This difference in weight and K was evidenced by a greater amount of mesenteric fat in the mainstem fish: fat covered at least 50% of the internal organs of 41.1% of the mainstem fish, but none of the LCR fish.

Juvenile humpback chub from the LCR were also more likely to be infected by the two species of parasites monitored in this study. Only 8.8% and 5.9% of the Colorado River fish were infected by *B. acheilognathi* and *Lernaea cyprinacea*, respectively, while 38.1% and 47.6% of the LCR fish were infected. The rate of *Lernaea* sp. infestation was significantly higher ($P=0.0054$) in the LCR, with a mean of 0.905 *Lernaea* / fish, but only 0.059 *Lernaea* / fish in the mainstem.

These results are surprising, given the belief among fisheries researchers that the LCR provides better habitat for young humpback chub than the mainstem Colorado River (Angradi et al. 1992; Valdez and Ryel 1995; Robinson et al. 1996; AGFD 1996b). However, 1996 may have been an unusual year. There was little spring flooding due to a drought, which may have permitted non-native fishes to increase in number: e.g., red shiners, which had rarely been caught in the LCR, became common and even invaded the mainstem during the small monsoon floods that occurred in 1996. Large numbers of non-native fishes may have intensified competition for food, thus decreasing growth and condition of humpback chub in the LCR. In addition to increased competition, the high prevalence and infestation rates of parasites in the LCR fish must also detrimentally affect growth and condition of these fish. Indeed, infection by at least one of the two monitored parasites significantly decreased weight ($P=0.0054$) and K ($P=0.0086$), but not length ($P=0.1126$). Therefore, it would appear that the LCR may not always be the excellent rearing habitat for humpback chub, and possibly other native species, that it has been thought to be.

Table 5. Sample size, number of fish infected with *Bothriocephalus acheilognathi*, percentage of fish infected, mean number and range of tapeworms / fish and mean number of tapeworms / infected fish in the Colorado River and tributaries, Grand Canyon, 1996.

Species	Number of Fish Sampled	Number of Fish Infected	Percentage of Fish Infected	Number of Tapeworms / Fish		Mean Number of Tapeworms / Infected Fish
				Mean	Range	
Bluehead Sucker	2	0	0	.	.	.
Flannelmouth Sucker	2	0	0	.	.	.
Humpback Chub	35	14	40.0	0.74	1 - 4	1.86
Speckled Dace	84	1	1.2	0.01	1	1.00
Fathead Minnow	259	19	7.3	0.08	1 - 3	1.11
Plains Killifish	42	1	2.4	0.02	1	1.00
Red Shiner	8	0	0	.	.	.

Asian Fish Tapeworm

The Asian fish tapeworm continues to infect cyprinid and cyprinodontid fishes of the Colorado River in Grand Canyon. Infestation rates and distribution were similar to that reported by Brouder and Hoffnagle (1997c) and Clarkson et al. (1997).

Prevalence

Four species of fish were found to be infected by the Asian fish tapeworm (Table 5). Forty percent of humpback chub, 7.3% of fathead minnow, 2.4% of plains killifish and 1.2% of speckled dace were infected while no sampled bluehead sucker, flannelmouth sucker or red shiner were infected. The infestation rate for humpback chub was 0.74 tapeworms / fish, 1.86 tapeworms / infected fish and a maximum infestation of four tapeworms. Infestation rates for all other species was low (<0.08 tapeworms/fish).

Brouder and Hoffnagle (1997c) and Clarkson et al. (1997) reported that humpback chub was the species most susceptible to infection by this parasite in Grand Canyon. Clarkson et al. (1997) reported that as many as 78% of the humpback chub in the LCR were infected in a given year from 1990-1994. This parasite is capable of killing its hosts (Hoffman and Schubert 1984) so infection of humpback chub is of particular concern.

Distribution

Fish infected with the Asian fish tapeworm were collected only in the LCR and in

Reaches 3 and 4 (Table 6). In the LCR, 78.6% of the sampled humpback chub and 6.8% of the fathead minnow were infected. In the mainchannel, infestation rates ranged from 15% in humpback chub in Reach 3 to 7.7% of plains killifish in Reach 4.

Brouder and Hoffnagle (1997c) reported similar results: infected fish were largely concentrated in and around the LCR. However, they also found infected fish 58 - 126 miles downstream from the LCR. They also found an infected speckled dace in the mouth of Kanab Creek, inducing concern that this might represent an invasion of this stream by the parasite. However, none of the 35 fish (5 plains killifish and 15 each of speckled dace and fathead minnow) examined from Kanab Creek in 1996 were infected.

Green Sunfish Diet

Sixteen adult green sunfish (155-196 mm TL) were collected from Kanab Creek in Grand Canyon during approximately one hour of angling by one technician. The sex ratio was 13M:3F and all females were gravid. Most (68.8%) stomachs were empty, but non-empty GI tracts primarily contained snails (Gastropoda) and aquatic insects (Hemiptera, Trichoptera and Odonata), although terrestrial insects (primarily Coleoptera) were also common (Table 7). These green sunfish in Kanab Creek were also piscivorous, as two (12.5%) GI tracts contained remains of speckled dace (40 and 46 mm TL). However, the rate of piscivory in these fish may be higher, as small fishes (particularly larvae) are quickly digested, leaving few, if any, identifiable remains. Prey density in Kanab Creek was not quantified in this study, so no inferences can be made on the selectivity of green sunfish for various food items. Also, food habits of fishes commonly change seasonally, with changing prey availability and it is possible that green sunfish may exploit YOY native fishes when they are most abundant (Bowen 1983). Young green sunfish eat zooplankton and adults are piscivorous and insectivorous (Carlander 1977 and references therein), so all age classes may compete with and prey upon larval and juvenile bluehead and flannelmouth suckers in Kanab Creek. Therefore, green sunfish viscera should be collected at frequent intervals throughout the year, particularly following native fish spawning activity, to better define the diet of this non-native fish and its potential for competition with and predation on native fishes.

CONCLUSIONS

The Experimental Beach/Habitat-Building Flood punctuated 1996 for the Colorado River aquatic fauna. This experimental flood reworked some backwater habitat and created or destroyed others, but it did not create useful rearing habitat for native fishes, as expected (AGFD 1996a; Brouder et al. *in review*). Fine sediments were scoured from backwaters and backwater benthic invertebrate densities were reduced by the experimental flood, but they rebounded quickly. The experimental flood did demonstrate that densities of non-native fathead minnow and plains killifish can be reduced, at least temporarily, and that native fishes are unaffected by such flows (AGFD

Table 6. Sample size, number of fish infected by *Bothriocephalus acheilognathi*, percentage of fish infected, mean number and range of tapeworms / fish and mean number of tapeworms / infected fish in each sampled reach and tributary of the Colorado River and tributaries, Grand Canyon, 1996.

Reach/Species	Number of Fish Sampled	Number of Fish Infected	Percentage of Fish Infected	Number of Tapeworms / Fish		
				Mean	Minimum	Maximum
<u>Paria River: RM 0.9</u>						
Speckled Dace	10	0	0	.	.	.
Fathead Minnow	1	0	0	.	.	.
<u>Reach 1: RM 0 - 29.3</u>						
Speckled Dace	5	0	0	.	.	.
<u>Reach 2: RM 29.3 - 61.5</u>						
Speckled Dace	1	0	0	.	.	.
Fathead Minnow	2	0	0	.	.	.
Plains Killifish	1	0	0	.	.	.
<u>Little Colorado River: RM 61.5</u>						
Humpback Chub	14	11	78.6	1.43	1	4
Speckled Dace	6	0	0	.	.	.
Fathead Minnow	44	3	6.8	0.07	1	1
Plains Killifish	19	0	0	.	.	.
Red Shiner	8	0	0	.	.	.
<u>Reach 3: RM 61.5 - 65.5</u>						
Humpback Chub	20	3	15.0	0.30	1	3
Speckled Dace	5	0	0	.	.	.
Fathead Minnow	22	2	9.1	0.09	1	1
Plains Killifish	4	0	0	.	.	.
<u>Reach 4: RM 65.5 - 76.7</u>						
Humpback Chub	1	0	0	.	.	.
Speckled Dace	8	1	12.5	0.13	1	1
Fathead Minnow	124	14	11.3	0.13	1	3
Plains Killifish	13	1	7.7	0.08	1	1
<u>Pipe Creek: RM 88.95</u>						
Speckled Dace	5	0	0	.	.	.

Table 6 continued.

Reach/Species	Number of Fish	Number of Fish	Percentage	Number of Tapeworms / Fish		
	Sampled	Infected	of Fish Infected	Mean	Minimum	Maximum
<u>Shinumo Creek: RM 108.6</u>						
Speckled Dace	5	0	0	.	.	.
<u>Reach 6: RM 116.5 - 140</u>						
Fathead Minnow	10	0	0	.	.	.
<u>Stone Creek: 131.8</u>						
Speckled Dace	3	0	0	.	.	.
<u>Reach 7: RM 140 - 182.5</u>						
Bluehead Sucker	2	0	0	.	.	.
Flannelmouth Sucker	2	0	0	.	.	.
Speckled Dace	7	0	0	.	.	.
Fathead Minnow	26	0	0	.	.	.
<u>Kanab Creek: RM 143.5</u>						
Speckled Dace	15	0	0	.	.	.
Fathead Minnow	15	0	0	.	.	.
Plains Killifish	5	0	0	.	.	.
<u>Matkatamiba Creek: RM 147.9</u>						
Speckled Dace	5	0	0	.	.	.
<u>Havasu Creek: RM 156.93</u>						
Speckled Dace	5	0	0	.	.	.
<u>Reach 8: RM 182.5 - 225.6</u>						
Speckled Dace	1	0	0	.	.	.
Fathead Minnow	10	0	0	.	.	.
<u>Spencer Creek: RM 246.0</u>						
Speckled Dace	3	0	0	.	.	.
Fathead Minnow	5	0	0	.	.	.

Table 7. Mean and standard deviation (SD) of the number of individuals of each prey item / gastrointestinal (GI) tract and the percentage of the GI tract contents (by number) of each prey item, and percent occurrence of each prey item found in 16 green sunfish caught in lower Kanab Creek, Grand Canyon, Arizona, 27 June 1996.

Taxa	Number of Individuals / GI Tract		Percentage of Contents by Number		Percent Occurrence
	Mean	SD	Mean	SD	
<u>Macroinvertebrates</u>	19.6	21.6	98.6	5.0	100
Gastropoda	10.7	20.7	27.4	34.2	62.5
Ostracoda	0.1	0.3	0.2	0.7	6.3
Insecta	8.9	6.7	71.0	34.9	100
Coleoptera	0.6	1.0	3.3	5.6	43.8
<i>Peltodytes</i> sp.	0.3	1.0	0.5	1.2	12.5
Unidentified Coleoptera*	0.3	0.5	2.9	5.7	31.3
Diptera	2.3	5.1	12.6	20.2	50.0
Chironomidae	0.4	0.8	4.1	9.0	31.3
Simuliidae	0.2	0.5	1.4	3.8	12.5
Unidentified Diptera*	1.7	5.2	7.2	18.0	43.8
Ephemeroptera	0.3	0.6	1.8	5.1	18.8
Hemiptera	1.6	1.7	15.5	16.1	75.0
Naucoridae (<i>Ambrysus</i> sp.)	0.6	0.8	7.1	11.6	37.5
Veliidae	0.9	1.3	7.8	13.8	50.0
Unidentified	0.1	0.3	0.6	1.9	12.5
Hymenoptera*	0.1	0.3	1.2	3.5	12.5
Lepidoptera	0.5	1.8	3.1	11.6	12.5
Megaloptera (<i>Corydalis</i> sp.)	0.8	1.6	9.2	20.1	25.0
Odonata (Anisoptera)	1.3	1.7	14.6	22.2	56.3
Trichoptera	0.8	0.7	5.9	7.0	62.5
Unidentified Insects*	0.6	1.2	3.3	8.5	25.0
<u>Fish</u>					
<i>Rhinichthys osculus</i>	0.1	0.3	1.4	5.0	12.5
<u>Total Prey Items</u>	19.8	21.6			

* includes terrestrial taxa.

1996a; Hoffnagle et al. *in review*; Valdez et al. *in review*). Further experimentation will be required to determine a hydrograph that can create longer-lasting backwaters for juvenile native fish habitat.

During 1996, native fishes continued to be captured in areas where they had previously been captured and spawning appeared to have been successful, with the capture of YOY of all native species. However, 1996 sampling yielded results which caused some concern. The reappearance of red shiners in the LCR, their dispersal into mainstem backwaters and the increasing prevalence of fathead minnow in the LCR are troubling. Our finding that juvenile humpback chub appear healthier in the mainstem Colorado river than in the LCR is surprising and may reflect increased competition for food with increasing numbers of non-native fishes in the LCR. Monitoring of native and non-native fish and their habitats, prey and parasites using the same, consistent methodologies is essential to documenting long-term changes in ecological data and should continue.

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Study	Sample Type	Habitat	Reach	River		Flow Stage	Estimated Discharge (cfs)	Set Date	Run Date	Gear	
				Mile or meters up tributaries	Side					Type	Effort
Trip 96-1											
3961001	N	MAIN	CR2	30.73	R	SH	16500	28 FEB 96	28 FEB 96	TL	1.53
3961002	N	MAIN	CR2	30.75	R	SH	16500	28 FEB 96	28 FEB 96	TL	1.6
3961003	N	MAIN	CR2	30.94	R	SH	16500	28 FEB 96	28 FEB 96	TL	1.71
3961004	O	BACK	CR2	33.2	L	SL	13500	29 FEB 96	.	BS	60
3961005	A	B&M	CR2	44.27	L	DC	13500	29 FEB 96	.	BL	297
3961008	N	MAIN	CR3	63.06	L	DC	13000	29 FEB 96	29 FEB 96	TL	1.97
3961009	N	MAIN	CR3	63.72	L	DC	13000	29 FEB 96	29 FEB 96	TL	1.79
3961010	N	MAIN	CR3	64.55	R	DC	13000	29 FEB 96	29 FEB 96	TL	1.79
3961011	N	MAIN	CR3	65.34	R	DC	13000	29 FEB 96	29 FEB 96	TL	1.76
3961012	T	MAIN	CR3	65.15	L	SH	20000	1 MAR 96	2 MAR 96	MT	25.23
3961013	T	MAIN	CR3	64.15	R	SH	20000	1 MAR 96	2 MAR 96	MT	25.5
3961014	T	MAIN	CR3	63.55	L	SH	20000	1 MAR 96	2 MAR 96	MT	25.5
3961015	T	MAIN	CR3	63.45	R	SH	20000	1 MAR 96	2 MAR 96	MT	25.78
3961016	T	MAIN	CR3	63.41	L	SH	20000	1 MAR 96	2 MAR 96	MT	26
3961017	T	MAIN	CR3	63.35	L	SH	20000	1 MAR 96	2 MAR 96	MT	26
3961018	T	MAIN	CR3	63.15	R	SH	20000	1 MAR 96	2 MAR 96	MT	26.25
3961019	T	MAIN	CR3	63.15	L	SH	20000	1 MAR 96	2 MAR 96	MT	26.25
3961020	T	MAIN	CR3	62.6	R	SH	20000	1 MAR 96	2 MAR 96	MT	26.33
3961021	T	MAIN	CR3	62.5	R	SH	20000	1 MAR 96	2 MAR 96	MT	26.33
3961022	T	MAIN	CR3	62.2	R	SH	20000	1 MAR 96	2 MAR 96	MT	26.28

Appendix 1 continued.

Study	Sample Type	Habitat	Reach	River		Side	Flow Stage	Estimated		Set Date	Run Date	Gear	
				Mile or meters up tributaries	up			Discharge (cfs)	Effort				
Trip 96-1 continued													
3961023	T	MAIN	CR3	61.8	L		SH	20000		1 MAR 96	2 MAR 96	MT	26.3
3961024	O	BACK	CR3	61.92	R		DC	15000		1 MAR 96		BL	48
3961025	A	B&M	CR2	60.85	L		DC	15000		1 MAR 96		BL	205
3961026	N	MAIN	CR3	61.86	R					1 MAR 96	1 MAR 96	TL	2.66
3961027	N	MAIN	CR3	61.53	L					1 MAR 96	1 MAR 96	TL	1.92
3961028	N	TRIB	LCR	61.5	L		DC			1 MAR 96	1 MAR 96	TL	2.12
3961029	N	MAIN	CR3	61.5	L					1 MAR 96	1 MAR 96	TL	2.67
3961030	N	MAIN	CR2	60.68	R					1 MAR 96	1 MAR 96	TL	1.67
3961031	N	MAIN	CR2	60.85	R		SL	14000		1 MAR 96	1 MAR 96	TL	2
3961032	E	MAIN	CR3	62	R		SL	15000		1 MAR 96		EL	70
3961033	E	MAIN	CR3	62.1	L		SL	15000		1 MAR 96		EL	162
3961034	E	MAIN	CR3	62.2	R		SL	15000		1 MAR 96		EL	167
3961035	E	MAIN	CR3	62.25	R		SL	15000		1 MAR 96		EL	241
3961036	E	MAIN	CR3	62.5	R		SL	15000		1 MAR 96		EL	192
3961037	E	MAIN	CR3	62.7	L		SL	15000		1 MAR 96		EL	292
3961038	E	MAIN	CR3	63.15	R		SL	15000		1 MAR 96		EL	285
3961039	E	MAIN	CR3	63.35	R		SL	15000		1 MAR 96		EL	446
3961040	E	MAIN	CR3	63.41	L		SL	15000		1 MAR 96		EL	237
3961041	E	MAIN	CR3	63.55	L		SL	15000		1 MAR 96		EL	292
3961042	E	MAIN	CR3	63.62	L		SL	15000		1 MAR 96		EL	288
3961043	O	BACK	CR3	63.08	L		DC	18000		2 MAR 96		BL	294
3961044	O	BACK	CR3	61.92	R		DC	18000		2 MAR 96		BL	
3961045	O	BACK	CR3	68.2	R		DC	18000		2 MAR 96		BL	52

Appendix 1 continued.

Study	Sample Type	Habitat	Reach	River		Side	Flow Stage	Estimated		Set Date	Run Date	Gear	
				Mile or meters up tributaries	Discharge (cfs)			Type	Effort				
Trip 96-1 continued													
3961046	A	B&M	CR2	58.68	L	DC		16000		2 MAR 96	.	BL	301
3961047	N	TRIB	LCR	61.5	L	SL		14000		2 MAR 96	2 MAR 96	TL	1.27
3961048	N	MAIN	CR3	61.8	R	SL		14000		2 MAR 96	2 MAR 96	TL	1.29
3961049	N	MAIN	CR2	60.85	R	SL		14000		2 MAR 96	2 MAR 96	TL	1.29
3961050	E	MAIN	CR3	64.05	L	SL		14000		2 MAR 96	.	EL	486
3961051	E	MAIN	CR3	64.2	R	SL		14000		2 MAR 96	.	EL	348
3961052	E	MAIN	CR3	64.25	R	SL		14000		2 MAR 96	.	EL	487
3961053	E	MAIN	CR3	64.55	L	SL		14000		2 MAR 96	.	EL	257
3961054	E	MAIN	CR3	65	L	SL		14000		2 MAR 96	.	EL	795
3961055	E	MAIN	CR3	65.18	R	SL		14000		2 MAR 96	.	EL	265
3961056	E	MAIN	CR3	65.2	L	SL		14000		2 MAR 96	.	EL	215
3961057	T	MAIN	CR3	65.15	L	SL		14000		2 MAR 96	3 MAR 96	MT	23.08
3961058	T	MAIN	CR3	64.15	L	SL		14000		2 MAR 96	3 MAR 96	MT	23.05
3961059	T	MAIN	CR3	63.55	L	SL		14000		2 MAR 96	3 MAR 96	MT	23.25
3961060	T	MAIN	CR3	63.45	R	SL		14000		2 MAR 96	3 MAR 96	MT	23.02
3961061	T	MAIN	CR3	63.41	L	SL		14000		2 MAR 96	3 MAR 96	MT	22.77
3961062	T	MAIN	CR3	63.35	R	SL		14000		2 MAR 96	3 MAR 96	MT	22.73
3961063	T	MAIN	CR3	63.15	R	SL		14000		2 MAR 96	3 MAR 96	MT	23.22
3961064	T	MAIN	CR3	62.7	R	SL		14000		2 MAR 96	3 MAR 96	MT	22.75
3961065	T	MAIN	CR3	62.6	R	SL		14000		2 MAR 96	3 MAR 96	MT	22.18
3961066	T	MAIN	CR3	62.5	R	SL		14000		2 MAR 96	3 MAR 96	MT	21.71
3961067	T	MAIN	CR3	62.2	R	SL		14000		2 MAR 96	3 MAR 96	MT	21.29
3961068	T	MAIN	CR3	61.8	L	SL		14000		2 MAR 96	3 MAR 96	MT	20.71

Appendix I continued.

Study	Sample Type	Habitat	Reach	River		Side	Flow		Set Date	Run Date	Gear Type	Effort
				Mile or meters up tributaries	Estimated Discharge (cfs)							
Trip 96-1 continued												
3961069	A	B&M	CR3	65.25	L	SL	SL	14000	3 MAR 96	.	BL	
3961070	O	BACK	CR4	66.88	L	SL	SL	13000	3 MAR 96	.	BL	22
3961071	O	BACK	CR4	68.45	R	SL	SL	13000	3 MAR 96	.	BL	18
3961072	O	BACK	CR4	68.46	R	SL	SL	13000	3 MAR 96	.	BL	228
3961073	N	MAIN	CR4	68.47	L	SL	SL	13000	3 MAR 96	3 MAR 96	TL	1.72
3961074	N	MAIN	CR4	68.38	L	SL	SL	13000	3 MAR 96	3 MAR 96	TL	1.73
3961075	N	MAIN	CR4	68.36	L	SL	SL	13000	3 MAR 96	3 MAR 96	TL	1.59
3961076	N	MAIN	CR4	68.06	L	SL	SL	13000	3 MAR 96	3 MAR 96	TL	1.66
3961077	T	MAIN	CR4	68.4	L	SL	SL	13000	3 MAR 96	4 MAR 96	MT	14.63
3961078	T	MAIN	CR4	68.25	L	SL	SL	13000	3 MAR 96	4 MAR 96	MT	15.4
3961079	T	MAIN	CR4	68.5	L	SL	SL	13000	3 MAR 96	4 MAR 96	MT	14.53
3961080	T	MAIN	CR4	67.85	L	SL	SL	13000	3 MAR 96	4 MAR 96	MT	14.72
3961081	T	MAIN	CR4	67.8	R	SL	SL	13000	3 MAR 96	4 MAR 96	MT	14.72
3961082	E	MAIN	CR4	68.4	L	SL	SL	13000	3 MAR 96	.	EL	238
3961083	E	MAIN	CR4	68.25	L	SL	SL	13000	3 MAR 96	.	EL	344
3961084	E	MAIN	CR4	68.5	L	SL	SL	13000	3 MAR 96	.	EL	546
3961085	E	MAIN	CR4	67.85	L	SL	SL	13000	3 MAR 96	.	EL	419
3961086	E	MAIN	CR4	67.8	R	SL	SL	13000	3 MAR 96	.	EL	186
3961087	E	MAIN	CR4	67.35	R	SL	SL	13000	3 MAR 96	.	EL	257
3961088	A	B&M	CR4	74.06	R	SL	SL	13000	4 MAR 96	.	BL	131
3961089	A	B&M	CR4	74.46	R	SL	SL	13000	4 MAR 96	.	BL	220
3961090	T	BACK	CR4	73.55	R	SL	SL	12000	4 MAR 96	5 MAR 96	MT	18.74
3961091	T	BACK	CR4	73.62	R	SL	SL	12000	4 MAR 96	5 MAR 96	MT	18.79

Appendix 1 continued.

Study	Sample Type	Habitat	Reach	River	Side	Flow Stage	Estimated	Set Date	Run Date	Gear Type	Effort
				Mile or meters up tributaries			Discharge (cfs)				
Trip 96-1 continued											
3961092	T	MAIN	CR4	73.63	L	SL	12000	4 MAR 96	5 MAR 96	MT	18.92
3961093	T	MAIN	CR4	73.73	L	SL	12000	4 MAR 96	5 MAR 96	MT	18.83
3961094	T	MAIN	CR4	74	R	SL	12000	4 MAR 96	5 MAR 96	MT	18.9
3961095	T	MAIN	CR4	74	L	SL	12000	4 MAR 96	5 MAR 96	MT	18.67
3961096	N	MAIN	CR4	74.42	L	SL	12000	4 MAR 96	4 MAR 96	TL	2.02
3961097	N	MAIN	CR4	74.14	R	SL	12000	4 MAR 96	4 MAR 96	TL	2.09
3961098	N	MAIN	CR4	73.98	R	SL	12000	4 MAR 96	4 MAR 96	TL	1.99
3961099	N	MAIN	CR4	73.67	L	SL	12000	4 MAR 96	4 MAR 96	TL	2.17
3961100	E	MAIN	CR4	73.9	L	SL	12000	4 MAR 96	.	EL	571
3961101	E	MAIN	CR4	74.25	R	SL	12000	4 MAR 96	.	EL	156
3961102	E	MAIN	CR4	74.05	L	SL	12000	4 MAR 96	.	EL	328
3961103	E	MAIN	CR4	74.3	L	SL	12000	4 MAR 96	.	EL	561
3961104	E	MAIN	CR4	74.55	R	SL	12000	4 MAR 96	.	EL	156
3961105	H	TRIB	SHM	0			.	5 MAR 96	6 MAR 96	HW	14.67
3961106	T	TRIB	SHM	150	R		.	5 MAR 96	6 MAR 96	MT	15.36
3961107	T	TRIB	SHM	100	R		.	5 MAR 96	6 MAR 96	MT	15.53
3961108	T	MAIN	CR5	108.57	R	SH	12000	5 MAR 96	6 MAR 96	MT	15.51
3961109	T	MAIN	CR5	108.52	R	SH	12000	5 MAR 96	6 MAR 96	MT	14.61
3961110	T	MAIN	CR5	107.98	R	SH	12000	5 MAR 96	6 MAR 96	MT	14.02
3961111	T	MAIN	CR7	127.53	R	SL	13000	6 MAR 96	7 MAR 96	MT	13.89
3961112	N	MAIN	CR5	108.52	R	SH	14000	5 MAR 96	5 MAR 96	TL	1.46
3961113	N	MAIN	CR5	108.45	L	SH	14000	5 MAR 96	5 MAR 96	TL	1.41
3961114	N	MAIN	CR5	108.29	L	SH	14000	5 MAR 96	5 MAR 96	TL	1.35

Appendix 1 continued.

Study	Sample Type	Habitat	Reach	River		Side	Flow		Estimated		Set Date	Run Date	Gear	
				Mile or meters up tributaries	tributaries		Stage	Discharge (cfs)	Type	Effort				
Trip 96-1 continued														
3961115	A	B&M	CR6	117.4	R	AC	AC	10000	6 MAR 96	.		BL	221	
3961116	O	BACK	CR7	125.25	R	AC	AC	11000	6 MAR 96	.		BL	24	
3961117	O	BACK	CR7	126.25	R	AC	AC	11000	6 MAR 96	.		BL	90	
3961118	N	MAIN	CR7	127.55	R	SH	SH	13000	6 MAR 96	6 MAR 96		TL	2.1	
3961119	N	MAIN	CR7	126.78	L	SH	SH	13000	6 MAR 96	6 MAR 96		TL	1.82	
3961120	N	MAIN	CR7	126.78	R	SH	SH	13000	6 MAR 96	6 MAR 96		TL	1.78	
3961121	N	MAIN	CR7	126.16	L	SH	SH	13000	6 MAR 96	6 MAR 96		TL	1.66	
3961122	T	MAIN	CR7	128.25	L	SL	SL	13000	6 MAR 96	7 MAR 96		MT	14.61	
3961123	T	MAIN	CR7	126.49	R	SL	SL	13000	6 MAR 96	7 MAR 96		MT	13.83	
3961124	T	MAIN	CR7	126.38	R	SL	SL	13000	6 MAR 96	7 MAR 96		MT	15.23	
3961125	E	MAIN	CR7	126.2	L	SH	SH	13000	6 MAR 96	.		EL	197	
3961126	E	MAIN	CR7	126.1	L	SH	SH	13000	6 MAR 96	.		EL	196	
3961127	E	MAIN	CR7	125.9	L	SH	SH	13000	6 MAR 96	.		EL	179	
3961128	E	MAIN	CR7	126.25	R	SH	SH	13000	6 MAR 96	.		EL	229	
3961129	O	BACK	CR7	139.25	L	SL	SL	9000	7 MAR 96	.		BS	72	
3961130	H	TRIB	KAN	0	L	DC	DC	4	7 MAR 96	8 MAR 96		HW	15.78	
3961131	T	TRIB	KAN	150	R			4	7 MAR 96	8 MAR 96		MT	18.97	
3961132	T	TRIB	KAN	300	R			4	7 MAR 96	8 MAR 96		MT	19.35	
3961133	O	BACK	CR7	144.5	L	DC	DC	11000	8 MAR 96	.		BL	28	
3961134	H	TRIB	HAV	0	L	DC	DC	66	8 MAR 96	9 MAR 96		HW	15.53	
3961135	T	TRIB	HAV	420	L			66	8 MAR 96	9 MAR 96		MT	18.65	
3961136	T	TRIB	HAV	420	L			66	8 MAR 96	9 MAR 96		MT	18.09	
3961137	O	TRIB	HAV	0	L	DC	DC	66	9 MAR 96	.		DN	.	

Appendix 1 continued.

Study	Sample		Habitat	Reach	River		Side	Estimated		Set Date	Run Date	Gear	
	Type				Mile or meters up tributaries	Flow Stage		Discharge (cfs)	Type			Effort	
Trip 96-1 continued													
3961138	O		BACK	CR7	161.1	L	SL	12000	9 MAR 96	.		BL	44
3961139	A		B&M	CR7	165	L	SL	12000	9 MAR 96	.		BL	.
3961140	O		BACK	CR7	165.12	R	AC	13000	9 MAR 96	.		BL	148
3961141	O		BACK	CR7	165.49	R	AC	13000	9 MAR 96	.		BL	52
3961142	O		BACK	CR7	165.43	R	AC	13000	9 MAR 96	.		BL	48
3961143	O		BACK	CR7	166.86	R	DC	12000	10 MAR 96	.		BL	38
3961144	O		BACK	CR7	166.85	L	DC	12000	10 MAR 96	.		BL	34
3961145	O		BACK	CR7	168.7	R	DC	12000	10 MAR 96	.		BS	26
3961146	O		BACK	CR7	168.7	L	DC	12000	10 MAR 96	.		BS	57
3961147	O		BACK	CR7	174.9	R	SL	11000	10 MAR 96	.		BL	152
3961148	O		BACK	CR8	182.52	R	SL	11000	11 MAR 96	.		BL	48
3961149	A		B&M	CR8	184.48	L	AC	12000	11 MAR 96	.		BL	208.5
3961150	O		BACK	CR8	185.55	L	SH	13000	11 MAR 96	.		BL	115
3961151	O		BACK	CR8	186	R	SH	13000	11 MAR 96	.		BL	57
3961152	O		BACK	CR8	186.45	L	SH	13000	11 MAR 96	.		BS	44
3961153	A		B&M	CR8	192.42	R	SH	13000	11 MAR 96	.		BL	336
3961154	A		B&M	CR8	193.95	R	SL	10000	12 MAR 96	.		BS	459
3961155	A		B&M	CR8	201.06	R	AC	12000	12 MAR 96	.		BL	321
3961156	O		MAIN	CR8	209	L	DC	15000	13 MAR 96	.		BL	118
Trip 96-3													
3963001	N		MAIN	CR2	30.3	L	DC	18000	18 APR 96	18 APR 96		TL	1.85
3963002	N		MAIN	CR2	30.47	R	DC	18000	18 APR 96	18 APR 96		TK	1.85

Appendix 1 continued.

Study	Sample Type	Habitat	Reach	River	Side	Flow Stage	Estimated Discharge (cfs)	Set Date	Run Date	Gear Type	Effort
				Mile or meters up tributaries							
Trip 96-3 continued											
3963003	N	MAIN	CR2	30.63	R	DC	18000	18 APR 96	18 APR 96	TL	1.87
3963004	N	MAIN	CR2	30.69	R	DC	18000	18 APR 96	18 APR 96	TN	1.82
3963005	T	MAIN	CR2	30.47	R	DC	18000	18 APR 96	19 APR 96	MT	14.75
3963006	T	MAIN	CR2	30.35	R	DC	18000	18 APR 96	19 APR 96	MT	14.77
3963007	T	MAIN	CR2	31.31	R	DC	18000	18 APR 96	19 APR 96	MT	14.78
3963008	T	BACK	CR2	31.38	R	DC	18000	18 APR 96	19 APR 96	MT	14.93
3963009	O	BACK	CR2	38.23	R	DC	18500	19 APR 96	.	BL	168
3963010	A	B&M	CR2	44.27	L	DC	18000	19 APR 96	.	BL	180
3963011	T	MAIN	CR2	61.7	L	DC	18500	19 APR 96	20 APR 96	MT	24.52
3963012	T	MAIN	CR3	62.22	R	DC	18500	19 APR 96	20 APR 96	MT	24.03
3963013	T	MAIN	CR3	62.45	R	DC	18500	19 APR 96	20 APR 96	MT	23.72
3963014	T	MAIN	CR3	62.66	R	DC	18500	19 APR 96	20 APR 96	MT	23.83
3963015	T	MAIN	CR3	62.77	R	DC	18500	19 APR 96	20 APR 96	MT	22.72
3963016	T	MAIN	CR3	63.16	R	DC	18500	19 APR 96	20 APR 96	MT	22.35
3963017	T	MAIN	CR3	63.37	R	DC	18500	19 APR 96	20 APR 96	MT	21.9
3963018	T	MAIN	CR3	63.42	L	DC	18500	19 APR 96	20 APR 96	MT	21.55
3963019	T	MAIN	CR3	63.54	R	DC	18500	19 APR 96	20 APR 96	MT	21.2
3963020	T	MAIN	CR3	63.54	L	DC	18500	19 APR 96	20 APR 96	MT	20.8
3963021	T	MAIN	CR3	64.3	R	DC	18500	19 APR 96	20 APR 96	MT	20.55
3963022	T	MAIN	CR3	65.14	L	DC	18500	19 APR 96	20 APR 96	MT	20.17
3963023	N	MAIN	CR3	65.25	L	DC	18000	19 APR 96	19 APR 96	TL	1.94
3963024	N	MAIN	CR3	65.18	R	DC	18000	19 APR 96	19 APR 96	TL	1.92
3963025	N	MAIN	CR3	64.52	R	DC	18000	19 APR 96	19 APR 96	TK	1.88

Appendix I continued.

Study	Sample Type	Habitat	Reach	River		Flow Stage	Estimated Discharge (cfs)	Set Date	Run Date	Gear	
				Mile or meters up	Side					Type	Effort
Trip 96-3 continued											
3963026	N	MAIN	CR3	64.3	L	DC	18000	19 APR 96	19 APR 96	TN	1.99
3963027	E	MAIN	CR3	64	L	SH	18000	19 APR 96	.	EL	577
3963028	E	MAIN	CR3	63.8	R	SH	18000	19 APR 96	.	EL	748
3963029	E	MAIN	CR3	64.4	L	SH	18000	19 APR 96	.	EL	500
3963030	E	MAIN	CR3	64.51	L	SH	18000	19 APR 96	.	EL	840
3963031	E	MAIN	CR3	65	L	SH	18000	19 APR 96	.	EL	378
3963032	A	B&M	CR2	58.68	L	SH	20000	20 APR 96	.	BL	122.5
3963033	O	BACK	CR2	60.1	R	DC	20000	20 APR 96	.	BL	420
3963034	A	B&M	CR2	60.85	L	DC	19000	20 APR 96	.	BL	80
3963035	T	MAIN	CR3	61.7	L	DC	18000	20 APR 96	21 APR 96	MT	23.93
3963036	T	MAIN	CR3	62.22	R	DC	18000	20 APR 96	21 APR 96	MT	24.32
3963037	T	MAIN	CR3	62.45	R	DC	18500	20 APR 96	21 APR 96	MT	24.52
3963038	T	MAIN	CR3	62.66	R	DC	18500	20 APR 96	21 APR 96	MT	25.03
3963039	T	MAIN	CR3	62.77	R	DC	18500	20 APR 96	21 APR 96	MT	25.28
3963040	T	MAIN	CR3	63.15	R	DC	18500	20 APR 96	21 APR 96	MT	25.65
3963041	T	MAIN	CR3	63.37	R	DC	18500	20 APR 96	21 APR 96	MT	31.48
3963042	T	MAIN	CR3	63.42	L	DC	18500	20 APR 96	21 APR 96	MT	31.78
3963043	T	MAIN	CR3	63.54	R	DC	18500	20 APR 96	21 APR 96	MT	32.38
3963044	T	MAIN	CR3	63.54	L	DC	18500	20 APR 96	21 APR 96	MT	32.45
3963045	T	MAIN	CR3	64.3	R	DC	18500	20 APR 96	21 APR 96	MT	28.6
3963046	T	MAIN	CR3	65.14	L	DC	18500	20 APR 96	21 APR 96	MT	24.92
3963047	N	MAIN	CR3	63.05	L	SL	18000	20 APR 96	20 APR 96	TK	1.95
3963048	N	MAIN	CR3	63.95	L	SL	18000	20 APR 96	20 APR 96	TL	1.93

Appendix 1 continued.

Study	Sample Type	Habitat	Reach	River	Side	Flow	Estimated	Set Date	Run Date	Gear Type	Effort
				Mile or meters up tributaries		Stage	Discharge (cfs)				
Trip 96-3 continued											
3963049	N	MAIN	CR3	63.95	R	SL	18000	20 APR 96	20 APR 96	TN	1.94
3963050	N	MAIN	CR3	64.01	L	SL	18000	20 APR 96	20 APR 96	TL	2.33
3963051	E	MAIN	CR3	62.01	R	DC	18000	20 APR 96	.	EL	264
3963052	E	MAIN	CR3	62.22	R	DC	18000	20 APR 96	.	EL	201
3963053	E	MAIN	CR3	62.25	R	DC	18000	20 APR 96	.	EL	290
3963054	E	MAIN	CR3	62.55	R	DC	18000	20 APR 96	.	EL	440
3963055	E	MAIN	CR3	62.67	R	DC	18000	20 APR 96	.	EL	216
3963056	E	MAIN	CR3	62.71	L	DC	18000	20 APR 96	.	EL	146
3963057	E	MAIN	CR3	63.18	R	DC	18000	20 APR 96	.	EL	693
3963058	O	BACK	CR3	62.22	R	SH	20000	21 APR 96	.	BL	171
3963059	A	B&M	CR3	64.06	L	DC	20000	21 APR 96	.	BL	351
3963060	A	B&M	CR3	65.25	L	AC	16000	21 APR 96	.	BL	104
3963061	N	MAIN	CR2	61.15	L	AC	17000	21 APR 96	21 APR 96	TN	1.92
3963062	N	MAIN	CR2	60.85	R	AC	17000	21 APR 96	21 APR 96	TL	2.1
3963063	N	MAIN	CR2	60.825	R	AC	17000	21 APR 96	21 APR 96	TL	2.17
3963064	N	MAIN	CR2	60.67	L	AC	17000	21 APR 96	21 APR 96	TL	2.38
3963065	E	MAIN	CR3	63.35	R	SH	18000	21 APR 96	.	EL	405
3963066	E	MAIN	CR3	63.4	L	SH	18000	21 APR 96	.	EL	518
3963067	E	MAIN	CR3	63.5	R	SH	18000	21 APR 96	.	EL	898
3963070	T	MAIN	CR3	61.7	L	AC	17000	21 APR 96	22 APR 96	MT	15.63
3963071	T	MAIN	CR3	62.22	R	AC	17000	21 APR 96	22 APR 96	MT	15.75
3963072	T	MAIN	CR3	62.45	R	AC	17000	21 APR 96	22 APR 96	MT	15.8
3963073	T	MAIN	CR3	62.66	R	AC	17000	21 APR 96	22 APR 96	MT	15.78

Appendix 1 continued.

Study	Sample Type	Habitat	Reach	River	Side	Flow	Estimated	Set Date	Run Date	Gear Type	Effort
				Mile or meters up tributaries		Stage	Discharge (cfs)				
Trip 96-3 continued											
3963074	T	MAIN	CR3	62.77	R	AC	17000	21 APR 96	22 APR 96	MT	15.92
3963075	T	MAIN	CR3	63.16	R	AC	17000	21 APR 96	22 APR 96	MT	15.95
3963076	T	MAIN	CR3	63.61	R	AC	17000	21 APR 96	22 APR 96	MT	10.23
3963077	T	MAIN	CR3	63.42	L	AC	17000	21 APR 96	22 APR 96	MT	10.5
3963078	T	MAIN	CR3	63.522	R	AC	17000	21 APR 96	22 APR 96	MT	10.2
3963079	T	MAIN	CR3	63.54	L	AC	17000	21 APR 96	22 APR 96	MT	10.38
3963080	T	MAIN	CR3	64.3	R	AC	17000	21 APR 96	22 APR 96	MT	14.52
3963081	T	MAIN	CR3	65.14	L	AC	17000	21 APR 96	22 APR 96	MT	18.43
3963082	A	B&M	CR2	55.5	R	AC	18000	19 APR 96	.	BL	432
3963090	O	BACK	CR4	65.65	L	SL	17000	22 APR 96	.	BL	264
3963091	O	BACK	CR4	66.22	L	SL	17000	22 APR 96	.	BL	760
3963092	O	BACK	CR4	66.85	L	AC	17000	22 APR 96	.	BL	434
3963100	O	BACK	CR5	87.45	R	SL	18000	24 APR 96	.	BL	117
3963101	O	BACK	CR5	115.7	R	AC	18000	25 APR 96	.	BL	125
3963102	A	B&M	CR6	117.4	R	AC	18000	25 APR 96	.	BL	176
3963103	O	BACK	CR6	119.4	R	AC	18000	25 APR 96	.	BL	102
3963104	O	MAIN	CR6	120.75	L	AC	19000	25 APR 96	.	BL	252
3963105	O	BACK	CR6	121.65	L	AC	20000	25 APR 96	.	BL	162
3963106	A	B&M	CR7	165	L	AC	18000	28 APR 96	.	BL	.
3963107	O	BACK	CR7	168.56	L	AC	18000	28 APR 96	.	BL	104
3963108	O	MAIN	CR7	168.7	L	AC	18500	28 APR 96	.	BL	24
3963109	O	BACK	CR7	165	L	AC	19000	28 APR 96	.	BL	72
3963110	O	BACK	CR7	172.43	L	SL	18000	29 APR 96	.	BL	124

Appendix 1 continued.

Study	Sample Type	Habitat	Reach	River		Flow Stage	Estimated		Set Date	Run Date	Gear	
				Mile or meters up	Side		Discharge (cfs)	Effort				
Trip 96-3 continued												
3963111	O	BACK	CR7	176.6	R	SL	18000	29 APR 96	.		BL	64
3963112	O	BACK	CR8	183	L	SL	18000	29 APR 96	.		BL	45
3963113	A	B&M	CR8	184.48	L	AC	19000	30 APR 96	.		BL	175
3963114	O	BACK	CR8	187.83	R	AC	19000	30 APR 96	.		BL	45
3963115	O	BACK	CR8	184.63	L	AC	19000	30 APR 96	.		BL	136
3963116	O	BACK	CR7	182.23	R	SL	19000	30 APR 96	.		BL	57
3963117	O	BACK	CR7	182.24	R	SL	19000	30 APR 96	.		BL	144
3963118	O	BACK	CR8	196.75	R	SL	18000	1MAY96	.		BL	33
3963119	O	BACK	CR8	199.02	R	SL	18000	1MAY96	.		BL	184
3963120	O	BACK	CR8	200.48	R	SL	18000	1MAY96	.		BL	900
3963121	O	BACK	CR8	210.45	R	DC	19500	2MAY96	.		BL	105
3963122	O	BACK	CR8	210.44	R	DC	19500	2MAY96	.		BL	42
3963123	O	BACK	CR8	211.5	R	DC	19500	2MAY96	.		BL	217
3963201	N	MAIN	CR4	68.34	L	SH	19000	22 APR 96	22 APR 96		TN	1.85
3963202	N	MAIN	CR4	68.32	L	SH	19000	22 APR 96	22 APR 96		TL	1.86
3963203	N	MAIN	CR4	68.07	L	SH	19000	22 APR 96	22 APR 96		TL	1.88
3963204	N	MAIN	CR4	68.07	R	SH	19000	22 APR 96	22 APR 96		TK	1.92
3963205	N	MAIN	CR4	74.01	L	DC	18000	23 APR 96	23 APR 96		TL	2.16
3963206	N	MAIN	CR4	74.43	R	DC	18000	23 APR 96	23 APR 96		TK	2.04
3963207	N	MAIN	CR4	75.04	L	DC	18000	23 APR 96	23 APR 96		TL	1.93
3963208	N	MAIN	CR4	73.91	R	DC	18000	23 APR 96	23 APR 96		TN	1.92
3963209	N	MAIN	CR5	108.05	R	DC	18000	24 APR 96	24 APR 96		TL	1.82
3963210	N	MAIN	CR5	108	R	DC	18000	24 APR 96	24 APR 96		TL	1.92

Appendix 1 continued.

Study	Sample Type	Habitat	Reach	River		Side	Estimated		Set Date	Run Date	Gear		
				Mile or meters up tributaries	Flow Stage		Discharge (cfs)	Type			Effort		
Trip 96-3 continued													
3963211	N	MAIN	CR5	107.92	L	DC	18000	24 APR 96	24 APR 96	TK	1.9		
3963212	N	MAIN	CR7	126.13	L	SH	20000	25 APR 96	25 APR 96	TL	1.96		
3963213	N	MAIN	CR7	127.55	R	SH	20000	25 APR 96	25 APR 96	TL	1.96		
3963214	N	MAIN	CR7	127.18	L	SH	20000	25 APR 96	25 APR 96	TK	1.92		
3963215	N	MAIN	CR7	127.17	R	SH	20000	25 APR 96	25 APR 96	TN	1.93		
3963301	E	MAIN	CR4	67.3	R	SH	18000	25 APR 96	.	EL	639		
3963302	E	MAIN	CR4	67.57	R	SH	18000	22 APR 96	.	EL	840		
3963303	E	MAIN	CR4	67.58	L	SH	18000	22 APR 96	.	EL	562		
3963304	E	MAIN	CR4	68.1	L	SH	18000	22 APR 96	.	EL	.		
3963305	E	MAIN	CR4	68.2	L	SH	18000	22 APR 96	.	EL	.		
3963306	E	MAIN	CR4	68.38	L	SH	18000	22 APR 96	.	EL	382		
3963307	E	MAIN	CR4	73.51	L	DC	18000	23 APR 96	.	EL	388		
3963308	E	MAIN	CR4	73.83	L	DC	18000	23 APR 96	.	EL	575		
3963309	E	MAIN	CR4	74.18	R	DC	18000	23 APR 96	.	EL	247		
3963310	E	MAIN	CR4	74.54	L	DC	18000	23 APR 96	.	EL	.		
3963311	E	MAIN	CR4	74.56	R	DC	18000	23 APR 96	.	EL	159		
3963312	E	MAIN	CR4	75.04	L	DC	18000	23 APR 96	.	EL	225		
3963313	E	MAIN	CR7	127.47	R	SH	20000	25 APR 96	.	EL	582		
3963314	E	MAIN	CR7	127.53	L	SH	20000	25 APR 96	.	EL	547		
3963315	E	MAIN	CR7	127.12	L	SH	20000	25 APR 96	.	EL	611		
3963316	E	MAIN	CR7	127.16	R	SH	20000	25 APR 96	.	EL	609		
3963317	E	MAIN	CR7	126.95	R	SH	20000	25 APR 96	.	EL	584		
3963318	E	MAIN	CR7	126.71	R	SH	20000	25 APR 96	.	EL	582		

Appendix 1 continued.

Study	Sample		Habitat	Reach	River		Side	Flow		Set Date	Run Date	Gear		
	Type				Mile or meters up	tributaries		Stage	Discharge (cfs)			Type	Effort	
Trip 96-3 continued														
3963319	E		MAIN	CR7	126.54	R		SH	20000	25 APR 96	.		EL	505
3963320	E		MAIN	CR7	142.46	R		SH	18000	26 APR 96	.		EL	402
3963321	E		MAIN	CR7	142.41	L		SH	18000	26 APR 96	.		EL	450
3963322	E		MAIN	CR7	142.61	R		SH	18000	26 APR 96	.		EL	267
3963323	E		MAIN	CR7	143.11	R		SH	18000	26 APR 96	.		EL	468
3963401	T		MAIN	CR4	66.84	L		SH	18500	22 APR 96	23 APR 96		MT	20.72
3963402	T		MAIN	CR4	67.05	L		SH	18500	22 APR 96	23 APR 96		MT	20.3
3963403	T		MAIN	CR4	67.75	R		SH	18500	22 APR 96	23 APR 96		MT	20.3
3963404	T		MAIN	CR4	68.12	L		SH	18500	22 APR 96	23 APR 96		MT	19.67
3963405	T		MAIN	CR4	68.12	L		SH	18500	22 APR 96	23 APR 96		MT	19.4
3963406	T		MAIN	CR4	68.25	L		SH	18500	22 APR 96	23 APR 96		MT	19.08
3963407	T		MAIN	CR4	68.29	L		SH	18500	22 APR 96	23 APR 96		MT	19.96
3963408	T		MAIN	CR4	74.52	L		SH	20000	23 APR 96	24 APR 96		MT	21.12
3963409	T		MAIN	CR4	74.03	L		SH	20000	22 APR 96	24 APR 96		MT	21.02
3963410	T		MAIN	CR4	74.15	L		SH	20000	23 APR 96	24 APR 96		MT	15.05
3963411	T		MAIN	CR4	73.45	L		SH	20000	23 APR 96	24 APR 96		MT	21.1
3963412	T		TRIB	SHM	33	L				24 APR 96	25 APR 96		MT	14.12
3963413	T		TRIB	SHM	20	L			20	24 APR 96	25 APR 96		MT	14.12
3963414	H		TRIB	SHM	0				20	24 APR 96	25 APR 96		HW	13.98
3963415	T		MAIN	CR5	108.52	R		SH	20000	24 APR 96	25 APR 96		MT	13.83
3963416	T		MAIN	CR5	108.51	R		SH	20000	24 APR 96	25 APR 96		MT	13.63
3963417	T		MAIN	CR5	108.31	L		SH	20000	24 APR 96	25 APR 96		MT	13.72
3963418	T		MAIN	CR5	108.13	R		SH	20000	24 APR 96	25 APR 96		MT	13.05

Appendix I continued.

Study	Sample Type	Habitat	Reach	River		Side	Flow Stage	Estimated		Set Date	Run Date	Gear Type	Effort
				Mile or meters up	tributaries			Discharge (cfs)					
Trip 96-3 continued													
3963419	T	MAIN	CR7	126.18	L	SH		20000		25 APR 96	26 APR 96	MT	14.93
3963420	T	MAIN	CR7	125.77	R	SH		20000		25 APR 96	26 APR 96	MT	13.93
3963421	T	MAIN	CR7	126.53	R	SH		20000		25 APR 96	26 APR 96	MT	14.95
3963422	T	MAIN	CR7	126.92	R	SH		20000		25 APR 96	26 APR 96	MT	14.98
3963423	T	MAIN	CR7	127.51	R	SH		20000		25 APR 96	26 APR 96	MT	14.78
3963424	T	MAIN	CR7	143.24	R	SH		20000		26 APR 96	27 APR 96	MT	15.08
3963425	T	MAIN	CR7	143.13	R	SH		20000		26 APR 96	27 APR 96	MT	15.1
3963426	T	MAIN	CR7	143.05	R	SH		20000		26 APR 96	27 APR 96	MT	15.12
3963427	H	TRIB	KAN	0				3		29 APR 96	27 APR 96	HW	16.77
3963428	T	TRIB	KAN	30				3		26 APR 96	27 APR 96	MT	14.57
3963429	T	TRIB	KAN	45				3		27 APR 96	27 APR 96	MT	15.13
3963430	T	TRIB	KAN	200				3		26 APR 96	27 APR 96	MT	15.28
3963431	T	TRIB	KAN	300				3		26 APR 96	27 APR 96	MT	15.4
3963433	H	TRIB	HAV	0				60		27 APR 96	28 APR 96	HW	12.83
3963434	T	TRIB	HAV	350	R			60		27 APR 96	28 APR 96	MT	14.5
3963435	T	TRIB	HAV	350	L			60		27 APR 96	28 APR 96	MT	13.87
Trip 96-4													
3964001	O	BACK	CR1	3.31	L	AC		18500		19 JUN 96	.	BL	176
3964002	O	BACK	CR1	3.36	L	AC		18500		19 JUN 96	.	BL	270
3964003	A	B&M	CR2	44.27	L	DC		20000		20 JUN 96	.	BL	191.25
3964004	O	BACK	CR2	46.58	R	SH		20000		20 JUN 96	.	BL	60
3964005	O	BACK	CR2	51.1	R	SL		18000		20 JUN 96	.	BL	190

Appendix 1 continued.

Study	Sample Type	Habitat	Reach	River		Side	Flow Stage	Estimated		Set Date	Run Date	Gear	
				Mile or meters up	tributaries			Discharge (cfs)	Effort				
Trip 96-4 continued													
3964006	A	B&M	CR2	55.5	R	SH	20000	20 JUN 96	.	BL	574		
3964007	S	B&M	CR2	58.68	L	DC	20000	21 JUN 96	22 JUN 96	SD	.		
3964008	A	B&M	CR2	58.68	L	DC	20000	21 JUN 96	.	BL	123.75		
3964009	O	BACK	CR2	60.71	R	DC	20000	21 JUN 96	.	BL	270		
3964010	A	B&M	CR2	60.85	L	DC	20000	21 JUN 96	.	BL	84		
3964011	O	BACK	CR3	62.45	R	SH	18000	22 JUN 96	.	BL	216		
3964012	A	B&M	CR3	65.25	L	SH	18000	22 JUN 96	.	BL	240		
3964013	O	TRIB	LCR	570	R	SL	235	22 JUN 96	.	BS	57		
3964014	O	TRIB	LCR	570	R	SL	235	22 JUN 96	.	BS	8		
3964015	O	TRIB	LCR	570	R	SL	235	22 JUN 96	.	SS	.		
3964016	O	TRIB	LCR	1150	R	SL	235	22 JUN 96	.	BS	54		
3964017	O	TRIB	LCR	1150	R	SL	235	22 JUN 96	.	BS	51		
3964018	O	TRIB	LCR	1130	L	SL	235	22 JUN 96	.	SS	2		
3964019	O	TRIB	LCR	1220	R	SL	235	22 JUN 96	.	BS	24		
3964020	O	TRIB	LCR	35		SL	235	22 JUN 96	.	SG	.		
3964021	S	B&M	CR2	60.85	L	SL	18000	22 JUN 96	23 JUN 96	SD	.		
3964022	O	TRIB	LCR	.		SL	235	23 JUN 96	.	SG	.		
3964023	O	BACK	CR3	65.25	L	SL	15000	23 JUN 96	.	BL	80		
3964024	O	BACK	CR3	65.25	L	SL	15000	23 JUN 96	.	BL	15		
3964025	O	POOL	CR4	66.2	L	SH	20000	24 JUN 96	.	BL	972		
3964026	A	B&M	CR6	117.4	R	SL	18000	26 JUN 96	.	BL	.		
3964027	O	BACK	CR5	118.75	R	DC	19000	26 JUN 96	.	BL	55		
3964028	O	BACK	CR5	120.05	R	DC	19000	26 JUN 96	.	BL	63		

Appendix I continued.

Study	Sample		Habitat	Reach	River Mile or meters up tributaries	Side	Flow Stage	Estimated		Set Date	Run Date	Gear		
	Type							Discharge (cfs)				Type	Effort	
Trip 96-4 continued														
3964029	O		BACK	CR5	122.28	L	DC	19000		26 JUN 96			BL	48
3964030	A		B&M	CR7	165	L	AC	19000		29 JUN 96			BL	390
3964031	O		BACK	CR7	165.17	L	AC	19500		29 JUN 96			BL	50
3964032	O		BACK	CR7	168.72	L	AC	18000		30 JUN 96			BL	48
3964033	O		BACK	CR7	170.57	L	AC	18500		30 JUN 96			BL	24
3964034	A		B&M	CR7	172.02	L	AC	18500		30 JUN 96			BL	174
3964035	O		BACK	CR7	176.52	R	AC	19000		30 JUN 96			BL	168
3964036	O		BACK	CR8	182.82	L	SL	18000		1 JUL 96			BL	84
3964037	O		BACK	CR8	194.13	L	DC	19000		2 JUL 96			SS	36
3964038	O		BACK	CR8	198	R	DC	19000		2 JUL 96			SS	33
3964039	O		BACK	CR8	198.12	R	SH	20000		2 JUL 96			BL	27
3964040	O		BACK	CR8	198.85	R	DC	19000		2 JUL 96			SS	10
3964041	O		BACK	CR8	199.02	R	SH	20000		2 JUL 96			BL	50
3964042	O		BACK	CR8	210.75	R	SH	20000		3 JUL 96			BL	33
3964043	O		BACK	CR8	211.5	R	DC	19500		3 JUL 96			BL	175
3964101	N		MAIN	CR2	31.15	R	AC	19000		19 JUN 96			TL	1.55
3964102	N		MAIN	CR2	30.68	R	AC	19000		19 JUN 96			TL	1.49
3964103	N		MAIN	CR2	30.55	R	AC	19000		19 JUN 96			TK	1.58
3964104	N		MAIN	CR2	30.53	R	AC	19000		19 JUN 96			TK	1.54
3964105	N		MAIN	CR2	61.26	L	SL	18000		20 JUN 96			TL	1.54
3964106	N		MAIN	CR2	60.85	R	SL	18000		20 JUN 96			TL	2.07
3964107	N		MAIN	CR2	60.65	R	SL	18000		20 JUN 96			TN	2.46
3964108	N		MAIN	CR3	62.48	R	SL	18000		21 JUN 96			TL	1.44

Appendix 1 continued.

Study	Sample Type	Habitat	Reach	River		Side	Flow		Set Date	Run Date	Gear Type	Effort
				Mile or meters up tributaries	Estimated Discharge (cfs)		Stage					
Trip 96-4 continued												
3964109	N	MAIN	CR3	63.04	L	SL	SL	18000	21 JUN 96	21 JUN 96	TN	1.44
3964110	N	MAIN	CR2	63.5	R	SL	SL	18000	21 JUN 96	21 JUN 96	TL	1.38
3964112	N	MAIN	CR3	63.29	L	SL	SL	18000	22 JUN 96	22 JUN 96	TL	1.96
3964113	N	MAIN	CR3	64	L	SL	SL	18000	22 JUN 96	22 JUN 96	TK	1.89
3964114	N	MAIN	CR3	64.5	R	SL	SL	18000	22 JUN 96	22 JUN 96	TK	1.87
3964115	N	MAIN	CR3	64.8	L	SL	SL	18000	22 JUN 96	22 JUN 96	TK	1.8
3964116	N	MAIN	CR4	68.5	L	SL	SL	18000	23 JUN 96	23 JUN 96	TL	1.5
3964117	N	MAIN	CR4	68.35	L	SL	SL	18000	23 JUN 96	23 JUN 96	TK	1.58
3964118	N	MAIN	CR4	68.2	L	SL	SL	18000	23 JUN 96	23 JUN 96	TK	1.5
3964119	N	MAIN	CR4	67.7	L	SL	SL	18000	23 JUN 96	23 JUN 96	TL	1.37
3964120	N	MAIN	CR4	74.05	R	DC	DC	18500	24 JUN 96	24 JUN 96	TL	1.76
3964121	N	MAIN	CR4	73.98	R	DC	DC	18500	24 JUN 96	24 JUN 96	TK	1.95
3964122	N	MAIN	CR4	75.03	L	DC	DC	18500	24 JUN 96	24 JUN 96	TN	1.74
3964123	N	MAIN	CR4	74.43	R	DC	DC	18500	24 JUN 96	24 JUN 96	TK	1.78
3964124	N	MAIN	CR5	107.96	L	DC	DC	19000	25 JUN 96	25 JUN 96	TL	1.6
3964125	N	MAIN	CR5	108.29	L	DC	DC	19000	25 JUN 96	25 JUN 96	TN	1.48
3964126	N	MAIN	CR5	108.52	R	DC	DC	19000	25 JUN 96	25 JUN 96	TM	1.52
3964127	N	MAIN	CR7	127.6	R	DC	DC	19000	26 JUN 96	26 JUN 96	TK	2.5
3964128	N	MAIN	CR7	127.1	R	DC	DC	19000	26 JUN 96	26 JUN 96	TL	2.02
3964129	N	MAIN	CR7	127.1	L	DC	DC	19000	26 JUN 96	26 JUN 96	TL	2.01
3964130	N	MAIN	CR7	125.7	R	DC	DC	19000	26 JUN 96	26 JUN 96	TL	1.99
3964201	E	MAIN	CR2	29.5	L	SH	SH	20000	19 JUN 96	.	EL	737
3964202	E	MAIN	CR2	30.5	R	SH	SH	20000	19 JUN 96	.	EL	407

Appendix I continued.

Study	Sample Type	Habitat	Reach	River		Side	Estimated		Set Date	Run Date	Gear Type	Effort
				Mile or meters up tributaries	Flow Stage		Discharge (cfs)					
Trip 96-4 continued												
3964203	E	MAIN	CR3	63.1	R	AC	18000	20 JUN 96	.		EL	1013
3964204	E	MAIN	CR3	62.5	L	AC	18000	20 JUN 96	.		EL	328
3964205	E	MAIN	CR3	62.4	R	AC	18000	20 JUN 96	.		EL	455
3964206	E	MAIN	CR3	62.1	L	AC	18000	20 JUN 96	.		EL	257
3964207	E	MAIN	CR3	63.45	R	SL	18000	21 JUN 96	.		EL	610
3964208	E	MAIN	CR3	63.5	L	DC	18000	21 JUN 96	.		EL	701
3964209	E	MAIN	CR3	63.6	R	DC	18000	21 JUN 96	.		EL	318
3964210	E	MAIN	CR3	63.65	L	DC	18000	21 JUN 96	.		EL	434
3964211	E	MAIN	CR3	63.8	L	DC	18000	21 JUN 96	.		EL	483
3964212	E	MAIN	CR3	63.75	L	DC	18000	21 JUN 96	.		EL	343
3964213	E	MAIN	CR3	64.1	L	DC	18000	21 JUN 96	.		EL	670
3964214	E	MAIN	CR3	63.9	R	DC	18000	21 JUN 96	.		EL	220
3964215	E	MAIN	CR3	64.15	R	DC	18000	21 JUN 96	.		EL	255
3964216	E	MAIN	CR3	64.3	L	DC	18000	22 JUN 96	.		EL	552
3964217	E	MAIN	CR3	64.3	R	SL	18000	22 JUN 96	.		EL	305
3964218	E	MAIN	CR3	64.65	L	SL	18000	22 JUN 96	.		EL	1410
3964219	E	MAIN	CR3	64.95	L	SL	18000	22 JUN 96	.		EL	518
3964220	E	MAIN	CR3	65.05	L	SL	18000	22 JUN 96	.		EL	1194
3964221	E	MAIN	CR3	65.18	L	SL	18000	22 JUN 96	.		EL	366
3964222	E	MAIN	CR3	61.15	L	SL	18000	22 JUN 96	.		EL	350
3964223	E	MAIN	CR4	67.3	R	SL	16000	23 JUN 96	.		EL	710
3964224	E	MAIN	CR4	67.8	R	SL	16000	23 JUN 96	.		EL	1037
3964225	E	MAIN	CR4	67.9	L	SL	16000	23 JUN 96	.		EL	710

Appendix 1 continued.

Study	Sample Type	Habitat	Reach	River		Side	Flow		Estimated		Set Date	Run Date	Gear	
				Mile or meters up tributaries	tributaries		Stage	Discharge (cfs)	Type	Effort				
Trip 96-4 continued														
3964226	E	MAIN	CR4	68.1	L	SL	SL	16000	23 JUN 96	.		EL	372	
3964227	E	MAIN	CR4	68.2	L	SL	SL	16000	23 JUN 96	.		EL	633	
3964228	E	MAIN	CR4	68.5	R	SL	SL	16000	23 JUN 96	.		EL	643	
3964230	E	MAIN	CR4	74.32	L	SH	SH	20000	24 JUN 96	.		EL	568	
3964231	E	MAIN	CR4	74.15	L	SH	SH	20000	24 JUN 96	.		EL	1809	
3964232	E	MAIN	CR4	74.65	R	SH	SH	20000	24 JUN 96	.		EL	338	
3964233	E	MAIN	CR5	108.6	R	SH	SH	20000	25 JUN 96	.		EL	263	
3964235	E	MAIN	CR5	108	R	SH	SH	20000	25 JUN 96	.		EL	545	
3964236	E	MAIN	CR5	108	L	SH	SH	20000	25 JUN 96	.		EL	254	
3964237	E	MAIN	CR5	107.9	L	SH	SH	20000	25 JUN 96	.		EL	458	
3964238	E	MAIN	CR7	127.5	R	DC	DC	19000	26 JUN 96	.		EL	693	
3964239	E	MAIN	CR7	127.5	L	DC	DC	19000	26 JUN 96	.		EL	436	
3964240	E	MAIN	CR7	126.65	R	SH	SH	20000	26 JUN 96	.		EL	395	
3964241	E	MAIN	CR7	126.3	L	SH	SH	20000	26 JUN 96	.		EL	227	
3964242	E	MAIN	CR7	126.3	L	DC	DC	19000	26 JUN 96	.		EL	309	
3964401	T	MAIN	CR2	30.29	R	AC	AC	18500	19 JUN 96	20 JUN 96		MT	13.32	
3964402	T	MAIN	CR2	30.51	R	AC	AC	18500	19 JUN 96	20 JUN 96		MT	13.32	
3964403	T	MAIN	CR2	30.57	R	AC	AC	18500	19 JUN 96	20 JUN 96		MT	12.3	
3964404	T	MAIN	CR2	30.83	R	AC	AC	18500	19 JUN 96	20 JUN 96		MT	13.32	
3964405	T	MAIN	CR2	30.92	R	AC	AC	18500	19 JUN 96	20 JUN 96		MT	13.3	
3964406	T	MAIN	CR3	61.7	L	SH	SH	20000	20 JUN 96	21 JUN 96		MT	23.03	
3964407	T	MAIN	CR3	61.63	R	SH	SH	20000	20 JUN 96	21 JUN 96		MT	22.45	
3964408	T	MAIN	CR3	62.45	R	SH	SH	20000	20 JUN 96	21 JUN 96		MT	23.18	

Appendix 1 continued.

Study	Sample		Habitat	Reach	River	Side	Flow Stage	Estimated	Set Date	Run Date	Gear Type	Effort
	Type	Mile or meters up tributaries			Discharge (cfs)							
Trip 96-4 continued												
3964409	T	MAIN	CR3	62.67	R	SH	SH	20000	20 JUN 96	21 JUN 96	MT	23.15
3964410	T	MAIN	CR3	62.78	R	SH	SH	20000	20 JUN 96	21 JUN 96	MT	23.1
3964411	T	MAIN	CR3	63.15	R	SH	SH	20000	20 JUN 96	21 JUN 96	MT	23.15
3964412	T	MAIN	CR3	63.42	L	SH	SH	20000	20 JUN 96	21 JUN 96	MT	23.12
3964413	T	MAIN	CR3	63.54	R	SH	SH	20000	20 JUN 96	21 JUN 96	MT	23.55
3964414	T	MAIN	CR3	63.54	R	SH	SH	20000	20 JUN 96	21 JUN 96	MT	23.77
3964415	T	MAIN	CR3	64.3	R	SH	SH	20000	20 JUN 96	21 JUN 96	MT	24.2
3964416	T	MAIN	CR3	65.18	L	SH	SH	20000	20 JUN 96	21 JUN 96	MT	24.48
3964417	H	TRIB	LCR	110	R	SL	SL	.	21 JUN 96	22 JUN 96	MH	23.77
3964418	H	TRIB	LCR	260	R	SL	SL	.	21 JUN 96	22 JUN 96	MH	23.77
3964419	N	MAIN	CR4	238.85	L	SL	SL	18000	22 JUN 96	22 JUN 96	TL	12.76
3964420	H	TRIB	LCR	520	R	SL	SL	.	21 JUN 96	22 JUN 96	MH	23.62
3964421	H	TRIB	LCR	530	R	SL	SL	.	21 JUN 96	22 JUN 96	MH	23.7
3964422	T	MAIN	CR3	61.7	L	DC	DC	18000	21 JUN 96	22 JUN 96	MT	23.73
3964423	T	MAIN	CR3	62.22	R	DC	DC	18000	21 JUN 96	22 JUN 96	MT	24.48
3964424	T	MAIN	CR3	62.45	R	DC	DC	18000	21 JUN 96	22 JUN 96	MT	24.47
3964425	T	MAIN	CR3	62.67	R	DC	DC	18000	21 JUN 96	22 JUN 96	MT	24.43
3964426	T	MAIN	CR3	62.78	R	DC	DC	18000	21 JUN 96	22 JUN 96	MT	24.47
3964427	T	MAIN	CR3	62.75	R	DC	DC	18000	21 JUN 96	22 JUN 96	MT	24.33
3964428	T	MAIN	CR3	63.42	L	DC	DC	18000	21 JUN 96	22 JUN 96	MT	24.4
3964429	T	MAIN	CR3	65.2	R	DC	DC	18000	21 JUN 96	22 JUN 96	MT	55.52
3964430	T	MAIN	CR3	63.54	R	DC	DC	18000	21 JUN 96	22 JUN 96	MT	24.22
3964431	T	MAIN	CR3	64.3	R	DC	DC	18000	21 JUN 96	22 JUN 96	MT	24.13

Appendix I continued.

Study	Sample Type	Habitat	Reach	River		Side	Flow		Estimated		Set Date	Run Date	Gear	
				Mile or meters up tributaries	tributaries		Stage	Discharge (cfs)	Type	Effort				
Trip 96-4 continued														
3964432	T	MAIN	CR3	65.18	L	DC	DC	18000	21 JUN 96	22 JUN 96	MT	25.18		
3964433	T	MAIN	CR3	61.7	L	DC	DC	18500	22 JUN 96	23 JUN 96	MT	15.8		
3964434	T	MAIN	CR3	69.87	R	DC	DC	18750	22 JUN 96	23 JUN 96	MT	132.08		
3964435	T	MAIN	CR3	62.45	R	DC	DC	18500	22 JUN 96	23 JUN 96	MT	15.53		
3964436	T	MAIN	CR3	62.67	R	DC	DC	18500	22 JUN 96	23 JUN 96	MT	15.58		
3964437	T	MAIN	CR3	62.78	R	DC	DC	18500	22 JUN 96	23 JUN 96	MT	15.73		
3964438	T	MAIN	CR3	63.15	R	DC	DC	18500	22 JUN 96	23 JUN 96	MT	15.72		
3964439	T	MAIN	CR3	63.42	L	DC	DC	18500	22 JUN 96	23 JUN 96	MT	15.55		
3964440	T	MAIN	CR3	63.54	R	DC	DC	18500	22 JUN 96	23 JUN 96	MT	14.93		
3964441	T	MAIN	CR3	63.54	R	DC	DC	18500	22 JUN 96	23 JUN 96	MT	14.52		
3964442	T	MAIN	CR3	64.3	R	DC	DC	18500	22 JUN 96	23 JUN 96	MT	14.13		
3964443	T	MAIN	CR3	65.18	L	DC	DC	18500	22 JUN 96	23 JUN 96	MT	13.63		
3964444	H	TRIB	LCR	260	R	SL	SL	235	22 JUN 96	23 JUN 96	MH	20.55		
3964445	H	TRIB	LCR	380	R	SL	SL	235	22 JUN 96	23 JUN 96	MH	19.73		
3964446	H	TRIB	LCR	520	R	SL	SL	235	22 JUN 96	23 JUN 96	MH	19.83		
3964447	H	TRIB	LCR	574	R	SL	SL	235	22 JUN 96	23 JUN 96	MH	19.72		
3964448	H	TRIB	LCR	590	R	SL	SL	235	22 JUN 96	23 JUN 96	MH	19.53		
3964449	T	MAIN	CR4	66.83	L	DC	DC	15500	23 JUN 96	24 JUN 96	MT	15.72		
3964450	T	MAIN	CR4	67.05	L	DC	DC	15400	23 JUN 96	24 JUN 96	MT	14.53		
3964451	T	MAIN	CR4	67.75	R	DC	DC	15500	23 JUN 96	24 JUN 96	MT	14.4		
3964452	T	MAIN	CR4	68.1	L	DC	DC	15375	23 JUN 96	24 JUN 96	MT	14.48		
3964453	T	MAIN	CR4	68.22	L	DC	DC	15500	23 JUN 96	24 JUN 96	MT	14.82		
3964454	T	MAIN	CR4	68.48	R	DC	DC	15500	23 JUN 96	24 JUN 96	MT	15.2		

Appendix 1 continued.

Study	Sample Type	Habitat	Reach	River		Side	Flow Stage	Estimated		Set Date	Run Date	Gear	
				Mile or meters up tributaries	tributaries			Discharge (cfs)	Effort				
Trip 96-4 continued													
3964455	T	MAIN	CR4	73.53	L	SH	19500	24 JUN 96	25 JUN 96	MT	16.78		
3964456	T	MAIN	CR4	74.03	L	SH	19500	24 JUN 96	25 JUN 96	MT	16.88		
3964457	T	MAIN	CR4	74.15	L	SH	19500	24 JUN 96	25 JUN 96	MT	16.75		
3964458	T	MAIN	CR4	74.51	L	SH	19500	24 JUN 96	25 JUN 96	MT	16.72		
3964459	H	TRIB	SHM	0		SL	11	25 JUN 96	26 JUN 96	HW	13.07		
3964460	T	TRIB	SHM	40		SL	11	25 JUN 96	26 JUN 96	MT	13.5		
3964461	T	TRIB	SHM	60		SL	11	25 JUN 96	26 JUN 96	MT	12.6		
3964462	T	MAIN	CR5	108.54	R	SH	20000	25 JUN 96	26 JUN 96	MT	15.17		
3964463	T	MAIN	CR5	108.51	R	SH	20000	25 JUN 96	26 JUN 96	MT	15.27		
3964464	T	MAIN	CR5	108.15	L	SH	20000	25 JUN 96	26 JUN 96	MT	15.23		
3964465	T	MAIN	CR5	108.05	R	SH	20000	25 JUN 96	26 JUN 96	MT	15.23		
3964466	T	MAIN	CR7	153.21	R	SH	20000	25 JUN 96	26 JUN 96	MT	13.95		
3964467	T	MAIN	CR7	126.92	R	SH	20000	26 JUN 96	27 JUN 96	MT	15.03		
3964468	T	MAIN	CR7	127.52	R	SH	20000	26 JUN 96	27 JUN 96	MT	15.13		
3964469	T	MAIN	CR7	126.13	L	SH	20000	26 JUN 96	27 JUN 96	MT	14.15		
3964470	T	MAIN	CR7	143.24	R	SH	20000	27 JUN 96	28 JUN 96	MT	18.17		
3964471	T	MAIN	CR7	143.13	R	SH	20000	27 JUN 96	28 JUN 96	MT	18.15		
3964472	T	MAIN	CR7	143.05	R	SH	20000	27 JUN 96	28 JUN 96	MT	18.13		
3964473	T	MAIN	CR7	142.88	R	SH	20000	27 JUN 96	28 JUN 96	MT	18.1		
3964474	H	TRIB	KAN	0		SL	4	27 JUN 96	28 JUN 96	HW	12.05		
3964475	T	TRIB	KAN	100	L	SL	4	27 JUN 96	28 JUN 96	MT	14.42		
3964476	T	TRIB	KAN	300		SL	4	27 JUN 96	28 JUN 96	MT	15.52		
3964477	T	TRIB	KAN	450		SL	4	27 JUN 96	28 JUN 96	MT	15.35		

Appendix 1 continued.

Study	Sample Type	Habitat	Reach	River		Flow Stage	Estimated Discharge		Set Date	Run Date	Gear	
				Mile or meters up tributaries	Side		(cfs)				Type	Effort
Trip 96-4 continued												
3964478	T	TRIB	KAN	475		SL	4	27 JUN 96	28 JUN 96		MT	15.42
3964479	T	TRIB	HAV	200	L	SL	76	28 JUN 96	29 JUN 96		MT	14.23
3964480	T	TRIB	HAV	200	R	SL	76	28 JUN 96	29 JUN 96		MT	14.48
3964481	H	TRIB	HAV	0		SL	76	28 JUN 96	29 JUN 96		HW	14
Trip 96-5												
3965001	O	BACK	CR1	3.18	L	SL	12000	8 SEP 96			BL	80
3965002	O	BACK	CR1	3.3	L	SL	12000	8 SEP 96			BL	200
3965003	O	BACK	CR1	10.22	L	SL	12000	8 SEP 96			CB	245
3965004	O	BACK	CR1	23.2	R	SL	12000	8 SEP 96			BL	87
3965005	O	BACK	CR1	29.1	R	SL	12000	8 SEP 96			BL	156
3965006	O	BACK	CR2	32.9	L	SL	12000	9 SEP 96			BL	133
3965007	O	BACK	CR2	37.4	R	SL	12000	9 SEP 96			BL	120
3965008	O	BACK	CR2	37.83	L	SL	12000	9 SEP 96			BL	156
3965009	A	B&M	CR2	44.27	L	SL	12000	9 SEP 96			BL	265
3965010	O	BACK	CR2	56.3	L	DC	12000	9 SEP 96			BL	95
3965011	S	B&M	CR2	58.68	L			10 SEP 96	11 SEP 96		SD	25.11
3965012	S	B&M	CR2	60.85	R	DC	14000	11 SEP 96	12 SEP 96		SD	24.67
3965013	A	B&M	CR2	58.68	L	DC	20000	10 SEP 96			BL	97.5
3965014	O	BACK	CR2	60.71	R	DC	20000	10 SEP 96			BL	245
3965015	A	B&M	CR2	60.85	L	DC	19500	10 SEP 96			BL	78
3965016	O	POOL	CR3	62.25	R	DC	19000	11 SEP 96			BL	30
3965017	O	BACK	CR3	62.7	R	DC	19000	11 SEP 96			BL	160

Appendix 1 continued.

Study	Sample Type	Habitat	Reach	River		Side	Estimated		Set Date	Run Date	Gear	
				Mile or meters up tributaries	Flow Stage		Discharge (cfs)	Type			Effort	
Trip 96-5 continued												
3965018	A	B&M	CR3	65.25	L	DC	15000	11 SEP 96	.		BL	185
3965019	O	BACK	CR3	65.06	R	DC	15000	11 SEP 96	.		BL	196
3965020	O	TRIB	LCR	1020	R	SH	250	11 SEP 96	.		BS	48
3965021	O	TRIB	LCR	990	R	SH	250	11 SEP 96	.		BS	52
3965022	O	TRIB	LCR	520	R	SH	250	11 SEP 96	.		BS	.
3965023	O	BACK	CR4	68.39	R	DC	15000	12 SEP 96	.		BL	205
3965024	O	BACK	CR4	68.38	R	DC	15000	12 SEP 96	.		BL	33
3965025	O	MAIN	CR4	69.48	R	DC	19000	13 SEP 96	.		BL	100
3965026	O	BACK	CR5	111.9	R	SL	11000	15 SEP 96	.		BL	54
3965027	O	BACK	CR5	117.24	L	SL	11000	15 SEP 96	.		BL	21
3965028	A	B&M	CR6	117.4	R	SL	11000	15 SEP 96	.		BL	97.5
3965029	O	BACK	CR6	119.54	L	SL	12004	15 SEP 96	.		BL	50
3965030	O	BACK	CR6	122.02	R	SL	12000	15 SEP 96	.		BL	75
3965031	O	BACK	CR6	122.55	L	SL	12004	15 SEP 96	.		BL	210
3965032	O	BACK	CR7	135.8	L	SL	11000	16 SEP 96	.		BS	12
3965033	O	BACK	CR7	138.97	R	SL	11000	16 SEP 96	.		BS	10
3965034	O	BACK	CR7	138.98	R	SL	11000	16 SEP 96	.		BS	42
3965035	O	BACK	CR7	160.87	L	AC	12000	18 SEP 96	.		BL	96
3965036	O	BACK	CR7	162.72	R	AC	12000	18 SEP 96	.		BL	95
3965037	O	BACK	CR7	164.75	L	AC	12000	18 SEP 96	.		BL	144
3965038	A	B&M	CR7	165	L	AC	12000	18 SEP 96	.		BL	140
3965039	O	BACK	CR7	172.4	L	DC	18000	19 SEP 96	.		BS	64
3965040	O	BACK	CR7	174.9	R	DC	13000	19 SEP 96	.		BL	110

Appendix 1 continued.

Study	Sample		Habitat	Reach	River		Side	Flow		Estimated		Set Date	Run Date	Gear	
	Type				Mile or meters up tributaries			Stage	Discharge (cfs)	Type	Effort				
Trip 96-5 continued															
3965041	O		BACK	CR7	174.89	R		DC	13000	19 SEP 96	.			BL	44
3965042	O		BACK	CR8	186.18	L		DC	13000	20 SEP 96	.			BL	188
3965043	O		BACK	CR8	186	R		DC	13000	20 SEP 96	.			BL	90
3965044	O		BACK	CR8	183	L		DC	12500	20 SEP 96	.			BL	30
3965045	O		BACK	CR8	197.52	R		DC	17500	21 SEP 96	.			BL	33
3965046	O		BACK	CR8	202.47	R		DC	17500	21 SEP 96	.			BL	168
3965047	O		BACK	CR8	212.72	R		DC	13000	22 SEP 96	.			BL	36
3965048	O		BACK	CR8	214.22	L		DC	13000	22 SEP 96	.			BL	72
3965201	N		MAIN	CR2	31	R		SL	12000	8 SEP 96	8 SEP 96			TK	2.08
3965202	N		MAIN	CR2	30.7	R		SL	12000	8 SEP 96	8 SEP 96			TN	2.11
3965203	N		MAIN	CR2	30.69	R		SL	12000	8 SEP 96	8 SEP 96			TL	2.25
3965204	N		MAIN	CR2	30.47	R		SL	12000	8 SEP 96	8 SEP 96			TK	1.53
3965205	N		MAIN	CR2	61.45	L		SL	12000	9 SEP 96	9 SEP 96			TN	1.81
3965206	N		MAIN	CR2	60.9	R		SL	12000	9 SEP 96	9 SEP 96			TK	1.86
3965207	N		MAIN	CR2	60.85	R		SL	12000	9 SEP 96	9 SEP 96			TK	1.85
3965208	N		MAIN	CR2	60.71	R		SL	12000	9 SEP 96	9 SEP 96			TM	1.87
3965209	N		MAIN	CR3	62.4	R		DC	15000	10 SEP 96	10 SEP 96			TL	2.15
3965210	N		MAIN	CR3	62.5	R		DC	15000	10 SEP 96	10 SEP 96			TK	1.83
3965211	N		MAIN	CR3	62.6	L		DC	15000	10 SEP 96	10 SEP 96			TN	1.79
3965212	N		MAIN	CR3	63.1	L		DC	15000	10 SEP 96	10 SEP 96			TL	1.86
3965213	N		MAIN	CR3	65.25	L		DC	14000	11 SEP 96	11 SEP 96			TK	1.75
3965214	N		MAIN	CR3	64.63	R		DC	14000	11 SEP 96	11 SEP 96			TM	1.75
3965215	N		MAIN	CR3	64.44	L		DC	14000	11 SEP 96	11 SEP 96			TN	1.82

Appendix 1 continued.

Study	Sample		Habitat	Reach	River		Side	Flow		Estimated		Set Date	Run Date	Gear	
	Type				Mile or meters up tributaries			Stage	Discharge (cfs)	Type	Effort				
Trip 96-5 continued															
3965216	N		MAIN	CR3	64.4	R		DC	14000	11 SEP 96	11 SEP 96			TK	1.81
3965217	N		MAIN	CR4	68.46	L		DC	14000	12 SEP 96	12 SEP 96			TN	2.09
3965218	N		MAIN	CR4	68.42	L		DC	14000	12 SEP 96	12 SEP 96			TK	2.11
3965219	N		MAIN	CR4	68.07	R		DC	14000	12 SEP 96	12 SEP 96			TL	2.09
3965220	N		MAIN	CR4	68.06	L		DC	14000	12 SEP 96	12 SEP 96			TM	2.14
3965221	N		MAIN	CR4	75.21	R		DC	16000	13 SEP 96	13 SEP 96			TN	1.89
3965222	N		MAIN	CR4	75.08	L		DC	16000	13 SEP 96	13 SEP 96			TL	1.79
3965223	N		MAIN	CR4	75.04	L		DC	16000	13 SEP 96	13 SEP 96			TM	1.81
3965224	N		MAIN	CR4	74.44	R		DC	16000	13 SEP 96	13 SEP 96			TL	1.77
3965225	N		MAIN	CR5	107.9	L		DC	16000	14 SEP 96	14 SEP 96			TN	2.06
3965226	N		MAIN	CR5	107.95	L		DC	16000	14 SEP 96	14 SEP 96			TL	2.09
3965227	N		MAIN	CR5	108.3	L		DC	16000	14 SEP 96	14 SEP 96			TM	2.02
3965228	N		MAIN	CR5	108.2	R		DC	16000	14 SEP 96	14 SEP 96			TL	2.1
3965229	N		MAIN	CR6	125.86	L		AC	16000	15 SEP 96	15 SEP 96			TL	1.86
3965230	N		MAIN	CR6	126.15	L		AC	16000	15 SEP 96	15 SEP 96			TM	1.96
3965231	N		MAIN	CR6	126.19	R		AC	16000	15 SEP 96	15 SEP 96			TK	1.89
3965232	N		MAIN	CR6	126.84	R		AC	16000	15 SEP 96	15 SEP 96			TL	2.02
3965233	N		MAIN	CR6	126.93	R		AC	16000	15 SEP 96	15 SEP 96			TL	1.75
3965300	E		MAIN	CR3	63.15	R		SL	12000	9 SEP 96	.			EL	1106
3965301	E		MAIN	CR3	62.61	L		SL	12000	9 SEP 96	.			EL	228
3965302	E		MAIN	CR3	62.45	R		SL	12000	9 SEP 96	.			EL	357
3965303	E		MAIN	CR3	61.95	R		SL	12000	9 SEP 96	.			EL	536
3965304	E		MAIN	CR3	63.43	R		DC	14000	10 SEP 96	.			EL	490

Appendix 1 continued.

Study	Sample Type	Habitat	Reach	River		Side	Flow		Estimated		Set Date	Run Date	Gear	
				Mile or meters up tributaries	tributaries		Stage	Discharge (cfs)	Type	Effort				
Trip 96-5 continued														
3965305	E	MAIN	CR3	63.49	L	DC	14000	10 SEP 96	.		EL	624		
3965306	E	MAIN	CR3	63.59	R	DC	14000	10 SEP 96	.		EL	314		
3965307	E	MAIN	CR3	63.61	L	DC	14000	10 SEP 96	.		EL	456		
3965308	E	MAIN	CR3	63.74	L	DC	14000	10 SEP 96	.		EL	375		
3965309	E	MAIN	CR3	63.91	L	DC	14000	10 SEP 96	.		EL	353		
3965310	E	MAIN	CR3	64.18	R	DC	14000	10 SEP 96	.		EL	588		
3965311	E	MAIN	CR3	64.31	R	DC	14000	11 SEP 96	.		EL	312		
3965312	E	MAIN	CR4	68.5	L	DC	15000	12 SEP 96	.		EL	276		
3965313	E	MAIN	CR4	68.2	L	DC	14000	12 SEP 96	.		EL	605		
3965314	E	MAIN	CR4	67.3	R	DC	14000	12 SEP 96	.		EL	625		
3965315	E	MAIN	CR4	67.8	R	DC	14000	12 SEP 96	.		EL	688		
3965316	E	MAIN	CR4	67.9	L	DC	14000	12 SEP 96	.		EL	505		
3965317	E	MAIN	CR4	68.1	L	DC	14000	12 SEP 96	.		EL	893		
3965318	E	MAIN	CR7	126.15	L	SL	12000	15 SEP 96	.		EL	231		
3965319	E	MAIN	CR7	126.42	R	SL	12000	15 SEP 96	.		EL	302		
3965320	E	MAIN	CR7	126.49	R	SL	12000	15 SEP 96	.		EL	225		
3965321	E	MAIN	CR7	126.55	R	SL	12000	15 SEP 96	.		EL	.		
3965322	E	MAIN	CR7	127.53	R	SL	12000	15 SEP 96	.		EL	609		
3965323	T	MAIN	CR7	127.5	L	SL	12000	15 SEP 96	.		EL	489		
3965401	T	MAIN	CR2	30.5	R	DC	13000	8 SEP 96	9 SEP 96		MT	13.27		
3965402	T	MAIN	CR2	30.6	R	DC	13000	8 SEP 96	9 SEP 96		MT	12.95		
3965403	T	MAIN	CR2	30.4	R	DC	13000	8 SEP 96	9 SEP 96		MT	13.42		
3965404	T	MAIN	CR2	30.1	L	DC	13000	8 SEP 96	9 SEP 96		MT	12.83		

Appendix 1 continued.

Study	Sample Type	Habitat	Reach	River		Side	Flow Stage	Estimated		Set Date	Run Date	Gear	
				Mile or meters up	tributaries			Discharge (cfs)	Effort				
Trip 96-5 continued													
3965405	T	MAIN	CR3	65.15	L	SL	SL	13000	9 SEP 96	10 SEP 96	MT	20.5	
3965406	T	MAIN	CR3	64.31	R	SL	SL	13000	9 SEP 96	10 SEP 96	MT	20.12	
3965407	T	MAIN	CR3	63.63	L	SL	SL	13000	9 SEP 96	10 SEP 96	MT	19.73	
3965408	T	MAIN	CR3	63.59	R	SL	SL	13000	9 SEP 96	10 SEP 96	MT	19.47	
3965409	T	MAIN	CR3	63.49	L	SL	SL	13000	9 SEP 96	10 SEP 96	MT	19.23	
3965410	T	MAIN	CR3	64.02	R	SL	SL	13000	9 SEP 96	10 SEP 96	MT	18.92	
3965411	T	MAIN	CR3	63.15	R	SL	SL	13000	9 SEP 96	10 SEP 96	MT	18.47	
3965412	T	MAIN	CR3	62.42	R	SL	SL	13000	9 SEP 96	10 SEP 96	MT	20.31	
3965413	T	MAIN	CR3	62.2	R	SL	SL	13000	9 SEP 96	10 SEP 96	MT	18.02	
3965414	T	MAIN	CR3	61.73	L	SL	SL	13000	9 SEP 96	10 SEP 96	MT	17.9	
3965415	T	MAIN	CR3	61.73	L	SH	SH	16000	10 SEP 96	11 SEP 96	MT	30.33	
3965416	T	MAIN	CR3	62.2	R	SH	SH	16000	10 SEP 96	11 SEP 96	MT	29.48	
3965417	T	MAIN	CR3	62.82	R	DC	DC	16000	9 SEP 96	11 SEP 96	MT	29.67	
3965418	T	MAIN	CR3	63.15	R	DC	DC	16000	9 SEP 96	11 SEP 96	MT	29.38	
3965419	T	MAIN	CR3	63.42	R	DC	DC	16000	9 SEP 96	11 SEP 96	MT	29.22	
3965420	T	MAIN	CR3	63.49	L	DC	DC	16000	10 SEP 96	11 SEP 96	MT	29.26	
3965421	T	MAIN	CR3	63.59	R	DC	DC	16000	10 SEP 96	11 SEP 96	MT	29.1	
3965422	T	MAIN	CR3	63.63	L	DC	DC	16000	10 SEP 96	11 SEP 96	MT	29.13	
3965423	T	MAIN	CR3	64.31	R	DC	DC	16000	10 SEP 96	11 SEP 96	MT	29.05	
3965424	T	MAIN	CR3	65.15	L	DC	DC	16000	10 SEP 96	11 SEP 96	MT	28.88	
3965425	H	TRIB	LCR	50	R	SL	SL	250	10 SEP 96	11 SEP 96	MH	24.23	
3965426	H	TRIB	LCR	150	R	SL	SL	250	10 SEP 96	11 SEP 96	MH	24.08	
3965427	H	TRIB	LCR	150	R	SL	SL	250	10 SEP 96	11 SEP 96	MH	24.07	

Appendix 1 continued.

Study	Sample Type	Habitat	Reach	River		Side	Flow		Set Date	Run Date	Gear Type	Effort
				Mile or meters up tributaries	Estimated Discharge (cfs)		Stage	Discharge				
Trip 96-5 continued												
3965428	H	TRIB	LCR	250	R	SL	250	10 SEP 96	11 SEP 96	MH	23.83	
3965429	H	TRIB	LCR	325	R	SL	250	10 SEP 96	11 SEP 96	MH	23.75	
3965430	H	TRIB	LCR	378	R	SL	250	10 SEP 96	11 SEP 96	MH	23.38	
3965431	H	TRIB	LCR	410	R	SL	250	10 SEP 96	11 SEP 96	MH	23.93	
3965432	H	TRIB	LCR	520	R	SL	250	10 SEP 96	11 SEP 96	MH	23.87	
3965433	H	TRIB	LCR	528	R	SL	250	10 SEP 96	11 SEP 96	MH	23.77	
3965434	H	TRIB	LCR	50	R	SL	250	11 SEP 96	12 SEP 96	MH	28.42	
3965435	H	TRIB	LCR	150	R	SL	250	11 SEP 96	12 SEP 96	MH	28.57	
3965436	H	TRIB	LCR	150	R	SL	250	11 SEP 96	12 SEP 96	MH	28.57	
3965437	H	TRIB	LCR	250	R	SL	250	11 SEP 96	12 SEP 96	MH	28.57	
3965438	H	TRIB	LCR	325	R	SL	250	11 SEP 96	12 SEP 96	MH	28.62	
3965439	H	TRIB	LCR	378	R	SL	250	11 SEP 96	12 SEP 96	MH	28.55	
3965440	H	TRIB	LCR	410	R	SL	250	11 SEP 96	12 SEP 96	MH	28.53	
3965441	H	TRIB	LCR	520	R	SL	250	11 SEP 96	12 SEP 96	MH	28.2	
3965442	H	TRIB	LCR	528	R	SL	250	11 SEP 96	12 SEP 96	MH	28.1	
3965443	T	MAIN	CR3	61.23	R	SL	13000	11 SEP 96	12 SEP 96	MT	27.82	
3965444	T	MAIN	CR3	62.2	R	SL	13000	11 SEP 96	12 SEP 96	MT	21.7	
3965445	T	MAIN	CR3	62.67	R	SL	13000	11 SEP 96	12 SEP 96	MT	21.62	
3965446	T	MAIN	CR3	63.15	R	SL	13000	11 SEP 96	12 SEP 96	MT	21.7	
3965447	T	MAIN	CR3	63.42	R	SL	13000	11 SEP 96	12 SEP 96	MT	21.68	
3965448	T	MAIN	CR3	63.49	L	SL	13000	11 SEP 96	12 SEP 96	MT	21.76	
3965449	T	MAIN	CR3	63.59	R	SL	13000	11 SEP 96	12 SEP 96	MT	21.83	
3965450	T	MAIN	CR3	63.63	L	SL	13000	11 SEP 96	12 SEP 96	MT	21.87	
											21.9	

Appendix 1 continued.

Study	Sample Type	Habitat	Reach	River		Side	Flow		Set Date	Run Date	Gear Type	Effort
				Mile or meters up tributaries	Estimated Discharge (cfs)		Stage	Discharge				
Trip 96-5 continued												
3965451	T	MAIN	CR3	64.31	R	SL	SL	13000	11 SEP 96	12 SEP 96	MT	21.9
3965452	T	MAIN	CR3	65.15	L	SL	SL	13000	11 SEP 96	12 SEP 96	MT	20.85
3965453	T	MAIN	CR4	66.95	L				12 SEP 96	13 SEP 96	MT	16.48
3965454	T	MAIN	CR4	67.18	L				12 SEP 96	13 SEP 96	TM	16.3
3965455	T	MAIN	CR4	67.72	R				12 SEP 96	13 SEP 96	MT	16.55
3965456	T	MAIN	CR4	67.81	R				12 SEP 96	13 SEP 96	MT	16.6
3965457	T	MAIN	CR4	68.12	L				12 SEP 96	13 SEP 96	MT	16.65
3965458	T	MAIN	CR4	68.15	L				12 SEP 96	13 SEP 96	MT	15.6
3965459	T	MAIN	CR4	73.53	L				13 SEP 96	14 SEP 96	MT	16.78
3965460	T	MAIN	CR4	74.03	L				13 SEP 96	14 SEP 96	TM	16.67
3965461	T	MAIN	CR4	74.05	R				13 SEP 96	14 SEP 96	MT	16.8
3965462	T	MAIN	CR4	74.15	L				13 SEP 96	14 SEP 96	MT	16.72
3965463	T	MAIN	CR4	74.51	L				13 SEP 96	14 SEP 96	MT	14.68
3965464	T	MAIN	CR5	108.21	R				14 SEP 96	15 SEP 96	MT	13.5
3965465	T	MAIN	CR5	108.27	R				14 SEP 96	15 SEP 96	MT	14.87
3965466	T	MAIN	CR5	108.39	R				14 SEP 96	15 SEP 96	MT	14.31
3965467	T	MAIN	CR5	108.51	R				14 SEP 96	15 SEP 96	MT	14.4
3965468	T	MAIN	CR5	108.57	R				14 SEP 96	15 SEP 96	MT	14.52
3965469	H	TRIB	SHM	0		SL	SL	9	14 SEP 96	15 SEP 96	HW	14.85
3965470	T	TRIB	SHM	60		SL	SL	9	14 SEP 96	15 SEP 96	MT	15.38
3965471	T	TRIB	SHM	70		SL	SL	9	14 SEP 96	15 SEP 96	MT	14.38
3965472	T	MAIN	CR7	126.15	L	SL	SL	12000	15 SEP 96	16 SEP 96	MT	15
3965473	T	MAIN	CR7	126.38	R	SL	SL	12000	15 SEP 96	16 SEP 96	MT	12.3

Appendix 1 continued.

Study	Sample Type	Habitat	Reach	River	Side	Flow	Estimated	Set Date	Run Date	Gear Type	Effort
				Mile or meters up tributaries		Stage	Discharge (cfs)				
Trip 96-5 continued											
3965474	T	MAIN	CR7	126.55	R	SL	12000	15 SEP 96	16 SEP 96	MT	14.53
3965475	T	MAIN	CR7	126.91	R	SL	12000	15 SEP 96	16 SEP 96	MT	15.03
3965476	T	MAIN	CR7	127.53	R	SL	12000	15 SEP 96	16 SEP 96	MT	15.13
3965477	T	MAIN	CR7	143.38	R	SL	12000	16 SEP 96	17 SEP 96	MT	22.98
3965478	T	MAIN	CR7	143.24	R	SL	12000	16 SEP 96	17 SEP 96	MT	22.77
3965479	T	MAIN	CR7	143.12	R	SL	12000	16 SEP 96	17 SEP 96	MT	22.88
3965480	H	TRIB	KAN	143.5	R	SL		16 SEP 96	17 SEP 96	HW	15.03
3965481	T	TRIB	KAN	45				16 SEP 96	17 SEP 96	MT	16.45
3965482	T	TRIB	KAN	300				16 SEP 96	17 SEP 96	MT	16.53
3965483	T	TRIB	KAN	1150				16 SEP 96	17 SEP 96	MT	16.45
3965484	T	TRIB	KAN	1300				16 SEP 96	17 SEP 96	MT	16.53
3965485	T	TRIB	KAN	1600				16 SEP 96	17 SEP 96	MT	16.75
3965486	H	TRIB	HAV	156.93	L			17 SEP 96	18 SEP 96	HW	13.83
3965487	T	TRIB	HAV	660	R			17 SEP 96	18 SEP 96	MT	14.13
3965488	T	TRIB	HAV	680	R			17 SEP 96	18 SEP 96	MT	14

Appendix 2. List of data codes used during AGFD monitoring trips in 1996.

SAMPLE TYPE

A Type A
 O Opportunistic
 T Minnow Trap
 H Hoop Net
 S Sonde Set
 P Parasite
 L Larval Sample

REACH CODESMainstem

CR1 Lee's Ferry (RM 0) to Shinumo Wash (RM 29.3)
 CR2 Shinumo Wash to Little Colorado R. (RM 61.5)
 CR3 LCR to Lava Chuar (RM 65.5)
 CR4 Lava Chuar to Hance Rapid (RM 76.7)
 CR5 Hance Rapid to Elves Chasm (RM 116.5)
 CR6 Elves Chasm to Forster Rapid (RM 122.8)
 CR7 Forster Rapid to Hell's Hollow (RM 182.5)
 CR8 Hell's Hollow to Diamond Creek (RM 225.6)
 CR9 Diamond Creek to Lake Mead (~RM 277)

Tributaries

PAR Paria River (RM 0.9 L)
 NKW Nankoweap Creek (RM 52.2 R)
 LCR Little Colorado River (RM 61.5 L)
 CHU Chuar Cr. (RM 65.3 R)
 CLR Clear Cr. (RM 84.03 R)
 BAC Bright Angel Cr. (RM 87.62 R)
 PIP Pipe Cr. (RM 88.95 L)
 HER Hermit Cr. (RM 95.0 L)
 CRY Crystal Cr. (RM 98.04 R)
 SHM Shinumo Cr. (RM 108.6 R)
 ELV Elves Chasm (RM 116.5 L)
 STC Stone Cr. (RM 131.8 R)
 TAP Tapeats Cr. (RM 133.83 R)

REACH CODES continuedTributaries continued

DRC Deer Cr. (RM 136.25 R)
 KAN Kanab Cr. (RM 143.5 R)
 OLO Olo Canyon (RM 145.5 L)
 HAV Havasu Cr. (RM 156.93 L)
 DIA Diamond Cr. (RM 225.6 L)
 TVT Travertine Cr. (RM 229.0)
 SPN Spencer Cr. (RM 246.0)

FLOW CODES

AC Ascending
 DC Descending
 SH Stable High
 SL Stable Low

HABITAT and SITE CODESConnected Backwaters: CB

CB Connected Backwater
 CF Connected Foot
 CC Connected Center
 CM Connected Mouth
 SP Spring

Isolated Backwater: IBMainchannel: MC

MC Mainchannel
 ME Mainchannel Eddy
 BE Backwater Eddy
 CO Cove
 SC Side Channel
 SP Spring

Tributaries: TM

TM Tributary Mouth
 RU Run
 RI Riffle
 PO Pool
 ED Eddy
 SP Spring

Appendix 2 continued.

GEAR CODES

BS	Small Bag Seine 15' x 6' x 1/8" (1/32" bag mesh)
BL	Large Bag Seine 30' x 6' x 1/4" (1/8" bag mesh)
SS	Small Straight Seine
SX	Straight Seine 50' x 6' x 3/16"
KS	Kick Seine 3' x 3' x 1/32"
DN	Dip Net
MH	Mini-Hoop Net 1.5' x 4' x 3/8"
HN	Hoop Net w/o wings 3' x 5' x 1/2"
HW	Hoop Net w/wings 4' x 5' x 3/8" x 40' wings
BH	Baited Hoop Net
MT	Minnow Trap
BT	Baited Minnow Trap
TN	Trammel Net
LD	Larval Drift
LL	Larval Light Trap
LT	Larval Trap (acrylic)
AN	Angling
BI	Bi-directional Trapnet (In)
BO	Bi-directional Trapnet (Out)
SD	Sonde

SUBSTRATE CODES

CL	Clay
SI	Silt
SA	Sand
GR	Gravel
PE	Pebble
CO	Cobble
BO	Boulder
BD	Bedrock
TR	Travertine

SPECIES CODESCommon

BHS	Bluehead Sucker
BNT	Brown Trout
CCF	Channel Catfish
CRP	Common Carp
FMS	Flannelmouth Sucker
HBC	HumpBack Chub
PKF	Plains Killifish
RBT	Rainbow Trout
SPD	Speckled Dace
STB	Striped Bass
NFC	No fish captured

Uncommon

BBH	Black Bullhead
BGS	Bluegill
BKT	Brook Trout
CUT	Cutthroat Trout
GSH	Golden Shiner
GSF	Green Sunfish
LMB	Largemouth Bass
RBS	RazorBack Sucker
RSH	Red Shiner
SMB	Smallmouth Bass
TFS	Threadfin Shad
UTC	Utah Chub
YBH	Yellow Bullhead
SUC	Sucker (unidentified)
UID	Unidentified

MATURITY CODES

0	Larval, Juvenile
1	Adult, Non-breeding
2	Gravid
3	Ripe
4	Spent
5	Tuberculate
6	Undetermined

Appendix 2 continued.

FIN CLIPS/PUNCHES

D Dorsal
UC Upper Caudal
LC Lower Caudal
CD Caudal
RP2 Right Pelvic
LP2 Left Pelvic

SEX

F Female
M Male
U Undetermined

DISPOSITION

RA Released Alive
MN Mortality, Not Preserved
MP Mortality, Preserved
SP Sacrificed, Preserved
VP Viscera Preserved
DP Found Dead, Preserved

Appendix 3. Mean, minimum and maximum temperature (°C) measured in backwaters and the mainchannel Colorado River, Grand Canyon, during AGFD Monitoring Trips 96-1, 96-3, 96-4, and 96-5, 1996.

Reach	Temperature (°C)					
	Backwaters			Mainchannel		
	Mean	Minimum	Maximum	Minimum	Mean	Maximum
<u>Trip 96-1</u>						
CR2	10.16	8.1	12.1	9.4	9.97	10.6
CR3	9.50	6.4	14.2	9.3	9.93	10.8
CR4	11.66	10.9	13.7	10.1	10.46	10.9
CR5				10.4	10.49	10.7
CR6	10.28	8.9	11.3	10.7	10.73	10.7
CR7	12.29	10.4	15.3	11.1	11.47	11.7
CR8	12.82	9.4	15.4	11.5	12.11	12.5
<u>Trip 96-3</u>						
CR2	10.77	8.9	17.7	9.0	10.80	14.8
CR3	12.56	9.9	19.4	10.0	10.61	11.0
CR4	10.70	10.3	11.1	11.1	11.55	12.1
CR5	12.70	11.5	13.9	11.7	11.70	11.7
CR6	12.06	11.7	13.3	11.7	13.37	14.2
CR7	13.91	11.5	21.0	11.7	12.02	15.5
CR8	14.22	13.0	16.0	12.3	12.33	12.3
<u>Trip 96-4</u>						
CR1	12.75	11.8	13.7			
CR2	14.71	12.4	21.1	6.7	11.53	15.8
CR3	15.98	6.4	21.3	8.0	12.39	13.4
CR4				8.5	12.88	13.4
CR5	15.57	15.0	16.7	9.1	13.37	14.0
CR6	14.48	14.4	14.7	14.0	14.03	14.0
CR7	16.94	14.8	19.1	9.5	14.29	14.7
CR8	17.58	16.2	18.8			
<u>Trip 96-5</u>						
CR1	12.66	10.8	14.7			
CR2	12.41	11.7	13.4	11.1	13.73	19.5
CR3	16.58	12.7	24.1	12.1	12.51	12.8
CR4	14.50	14.5	14.5	12.1	12.47	14.1
CR5	13.70	13.4	14.0	13.1	13.17	13.4
CR6	14.61	13.1	17.0	13.3	14.03	14.1
CR7	15.20	13.9	22.7	13.7	13.81	14.1
CR8	15.23	14.4	16.5			

Appendix 4. Mean, minimum and maximum turbidity (NTU) measured in backwaters and the mainchannel Colorado River, Grand Canyon, during AGFD Monitoring Trips 96-1, 96-3, 96-4, and 96-5, 1996.

Reach	Turbidity (NTU)					
	Backwaters			Mainchannel		
	Mean	Minimum	Maximum	Mean	Minimum	Maximum
<u>Trip 96-1</u>						
CR2	9.27	5.8	14.0	6.35	5.4	8.0
CR3	24.89	7.2	39.0	6.31	5.4	10.0
CR4	12.36	5.7	28.0	9.59	7.0	12.0
CR5				8.43	8.0	8.6
CR6	15.33	13.0	20.0	9.00	9.0	9.0
CR7	9.79	7.4	20.8	9.06	7.4	10.0
CR8	7.62	5.4	13.0	10.93	5.8	18.5
<u>Trip 96-3</u>						
CR2	9.82	8.0	14.0	9.72	8.0	17.0
CR3	12.00	9.0	16.0	9.46	8.0	10.0
CR4	10.00	10.0	10.0	11.50	11.0	12.0
CR5	19.00	11.0	27.0	11.50	11.5	11.5
CR6	14.00	12.0	18.0	13.33	12.0	14.0
CR7	14.47	9.2	19.0	16.40	8.3	23.0
CR8	14.08	8.8	25.0	16.00	16.0	16.0
<u>Trip 96-4</u>						
CR1	10.50	7.0	14.0			
CR2	5.39	2.4	8.5	6.68	3.6	9.0
CR3	6.80	4.2	8.2	4.17	1.8	7.0
CR4				4.84	4.4	5.4
CR5						
CR6						
CR7						
CR8						
<u>Trip 96-5</u>						
CR1	2.06	1.4	3.6			
CR2	6.83	3.7	11.0	2.74	1.5	6.2
CR3	62.40	15.0	93.0	93.88	45.5	120.0
CR4	98.00	98.0	98.0	59.08	39.0	166.0
CR5	64.00	50.0	78.0			
CR6	75.33	56.0	144.0	143.17	90.0	148.0
CR7	1555.25	87.0	6872.0	3885.81	148.0	5949.0
CR8	1017.71	328.0	1728.0			

Appendix 5. Mean, minimum, and maximum specific conductivity ($\mu\text{S}/\text{cm}$) measured in backwaters and the mainchannel Colorado River, Grand Canyon, during AGFD Monitoring Trips 96-1, 96-3, 96-4, and 96-5, 1996.

Reach	Specific Conductance ($\mu\text{S}/\text{cm}$)					
	Backwaters			Mainchannel		
	Mean	Minimum	Maximum	Mean	Minimum	Maximum
<u>Trip 96-1</u>						
CR2	827.0	800	850	815.8	760	830
CR3	901.4	840	950	866.0	820	950
CR4	938.8	930	950	940.0	940	940
CR5				902.9	900	910
CR6	873.3	810	930	900.0	900	900
CR7	945.4	890	990	890.0	890	890
CR8	935.0	910	970	932.0	930	940
<u>Trip 96-3</u>						
CR2	765.8	750	790	775.0	704	815
CR3	800.0	800	800	793.9	710	880
CR4	910.0	870	950	796.3	780	810
CR5	800.0	800	800			
CR6						
CR7						
CR8						
<u>Trip 96-4</u>						
CR1	675.0	670	680			
CR2	680.0	680	680	684.2	680	740
CR3	750.0	750	750	747.8	45	810
CR4				741.4	730	750
CR5	730.0	720	740	746.4	745	750
CR6				365.0	365	365
CR7	683.0	375	780	731.8	730	735
CR8	768.8	730	820			
<u>Trip 96-5</u>						
CR1	672.0	660	680			
CR2	686.0	680	690	673.8	670	680
CR3	740.0	740	740	743.6	705	4019
CR4	730.0	730	730	742.5	735	750
CR5	740.0	730	750	746.2	745	750
CR6	753.3	750	760	770.0	770	770
CR7	788.9	740	830	759.1	745	770
CR8	748.6	740	760			

Appendix 6. Mean, minimum, and maximum dissolved oxygen (% saturation) measured in backwaters and the mainchannel Colorado River, Grand Canyon, during AGFD Monitoring Trips 96-1, 96-3, 96-4, and 96-5, 1996.

Reach	Dissolved Oxygen (% saturation)					
	Backwaters			Mainchannel		
	Mean	Minimum	Maximum	Mean	Minimum	Maximum
<u>Trip 96-1</u>						
CR2	101.64	80.0	134.9	92.40	84.1	101.7
CR3	82.81	66.1	95.4	93.47	92.1	96.5
CR4	96.55	77.3	114.3	95.41	94.2	96.5
CR5				97.46	97.4	97.6
CR6	94.23	92.8	95.6	100.40	100.4	100.4
CR7	96.29	89.9	102.3	98.00	94.2	99.9
CR8	99.53	92.8	107.3	101.88	99.9	104.3
<u>Trip 96-3</u>						
CR2	98.84	92.0	124.0	95.52	92.2	98.9
CR3	103.08	90.0	132.7	98.96	96.4	100.6
CR4	93.50	90.5	96.5	101.82	99.5	102.0
CR5						
CR6						
CR7						
CR8						
<u>Trip 96-4</u>						
CR1	81.05	80.2	81.9			
CR2	65.83	48.8	99.5	96.06	93.0	97.9
CR3	75.80	48.3	103.3	95.37	49.5	98.9
CR4				94.92	48.3	97.3
CR5	67.30	49.8	98.6	95.03	94.9	95.5
CR6	49.35	49.4	49.4			
CR7	78.25	49.6	95.9	97.61	96.5	99.2
CR8	91.76	82.5	99.1			
<u>Trip 96-5</u>						
CR1	80.94	59.7	106.5			
CR2	93.74	87.6	99.4	98.03	96.3	100.7
CR3	89.80	89.8	89.8	97.03	92.8	100.3
CR4	95.70	95.7	95.7	96.00	93.3	99.1
CR5	95.40	95.2	95.6	96.58	94.8	97.2
CR6	97.20	94.4	100.8	102.00	102.0	102.0
CR7	93.71	91.4	96.5	100.42	100.1	102.0
CR8	95.33	93.1	97.6			

Appendix 7. Mean, minimum, and maximum pH measured in backwaters and the mainchannel Colorado River, Grand Canyon, during AGFD Monitoring Trips 96-1, 96-3, 96-4, and 96-5, 1996.

Reach	pH					
	Backwaters			Mainchannel		
	Mean	Minimum	Maximum	Mean	Minimum	Maximum
<u>Trip 96-1</u>						
CR2	8.16	8.0	8.5	7.93	7.7	8.0
CR3	8.10	7.9	8.3	8.00	7.9	8.1
CR4	8.10	7.9	8.4	8.10	8.1	8.1
CR5				8.24	8.2	8.3
CR6	8.30	8.3	8.3	8.30	8.3	8.3
CR7	8.26	8.1	8.3	8.23	8.2	8.3
CR8	8.17	8.0	8.3	8.32	8.2	8.4
<u>Trip 96-3</u>						
CR2	8.03	7.5	8.4	8.20	7.8	8.3
CR3	7.84	7.5	8.4	8.12	7.5	8.2
CR4	7.75	7.6	7.9	8.00	8.0	8.1
CR5	8.30	8.3	8.3			
CR6						
CR7						
CR8						
<u>Trip 96-4</u>						
CR1	8.20	8.2	8.2			
CR2	7.29	4.2	8.4	8.37	8.3	8.4
CR3	8.30	8.2	8.4	8.67	4.2	81.0
CR4				8.39	8.3	8.5
CR5	7.13	4.2	8.6	8.50	8.5	8.5
CR6	4.25	4.3	4.3	4.25	4.3	4.3
CR7	7.74	4.3	8.6	8.54	8.4	8.8
CR8	8.84	8.5	9.4			
<u>Trip 96-5</u>						
CR1	8.92	8.8	9.1			
CR2	8.88	8.8	8.9	8.90	8.9	8.9
CR3	8.90	8.9	8.9	8.90	8.9	8.9
CR4	8.90	8.9	8.9	8.93	8.9	9.4
CR5	9.10	9.1	9.1	9.10	9.1	9.1
CR6	9.00	9.0	9.0	9.00	9.0	9.0
CR7	9.08	9.0	9.1	9.06	9.0	9.1
CR8	9.11	9.0	9.2			

Appendix 8. Mean, minimum, and redox potential (mV) measured in backwaters and the mainchannel Colorado River, Grand Canyon, during AGFD Monitoring Trips 96-1, 96-3, 96-4, and 96-5, 1996.

Reach	Redox Potential (mV)					
	Backwaters			Mainchannel		
	Mean	Minimum	Maximum	Mean	Minimum	Maximum
<u>Trip 96-1</u>						
CR2	362.5	311	417	348.4	321	413
CR3	361.4	354	373	376.0	321	413
CR4	373.1	336	381	381.6	375	386
CR5				369.4	358	374
CR6	363.3	361	366	360.0	360	360
CR7	363.5	338	408	346.0	338	350
CR8	369.2	362	374	371.8	366	384
<u>Trip 96-3</u>						
CR2	333.6	318	359	332.0	321	350
CR3	359.8	320	385	328.1	310	380
CR4	368.0	359	377	363.5	350	375
CR5						
CR6						
CR7						
CR8						
<u>Trip 96-4</u>						
CR1	317.0	313	321			
CR2	515.0	302	940	322.1	301	344
CR3	326.0	314	338	362.8	301	850
CR4				329.7	315	351
CR5	268.2	161	330	353.3	348	355
CR6	171.0	171	171			
CR7	317.6	180	366	325.2	157	340
CR8	321.2	180	360			
<u>Trip 96-5</u>						
CR1	362.4	341	384			
CR2	372.6	357	387	357.7	348	370
CR3	378.0	378	378	361.5	353	535
CR4	342.0	342	342	382.6	367	390
CR5	356.0	351	361	366.4	360	369
CR6	336.0	325	344	328.0	328	328
CR7	340.4	331	348	339.2	328	344
CR8	328.9	310	360			

Appendix 9. Mean, minimum, and maximum temperature ($^{\circ}\text{C}$), turbidity (NTU), and specific conductance ($\mu\text{S}/\text{cm}$) measured in the Little Colorado River, Shinumo Creek, Kanab Creek, and Havasu Creek, tributaries of the Colorado River in Grand Canyon during AGFD Monitoring Trips 96-1, 96-3, 96-4, and 96-5, 1996.

Tributary/ Trip	Temperature ($^{\circ}\text{C}$)			Turbidity (NTU)			Specific conductance ($\mu\text{S}/\text{cm}$)		
	Mean	Minimum	Maximum	Mean	Minimum	Maximum	Mean	Minimum	Maximum
<u>Little Colorado River</u>									
96-1									
96-3									
96-4	24.60	24.0	25.0						
96-5	21.24	19.8	22.2	20937.50	6500.0	25750.0	4255.0	3960	5460
<u>Shinumo Creek</u>									
96-1	10.50	10.5	10.5	14.50	14.5	14.5	400.5	400	401
96-3				23.50	23.5	23.5			
96-4	20.85	14.3	21.5				320.0	320	320
96-5	19.10	19.1	19.1	6.25	6.3	6.3	330.0	330	330
<u>Kanab Creek</u>									
96-1	10.50	10.5	10.5	7.40	7.4	7.4	1300.0	1300	1300
96-3	20.06	20.1	20.3	11.00	11.0	11.0			
96-4	20.15	13.7	21.4				1205.0	1205	1205
96-5	18.10	18.1	18.1	14.08	13.0	41.0	1255.4	1255	1265
<u>Havasu Creek</u>									
96-1	14.93	14.7	15.0	5.76	5.8	5.9	770.0	770	770
96-3	15.00	15.0	15.0	13.00	13.0	13.0			
96-4	18.05	13.2	20.9				698.6	685	835
96-5	19.22	18.5	19.3	6.39	6.3	6.4	680.5	680	685

Appendix 10. Mean, minimum, and maximum dissolved oxygen (% saturation), pH, and redox potential (mV) measured in the Little Colorado River, Shinumo Creek, Kanab Creek, and Havasu Creek, tributaries of the Colorado River in Grand Canyon during AGFD Monitoring Trips 96-1, 96-3, 96-4, and 96-5, 1996.

Tributary/ Trip	Dissolved Oxygen (% saturation)			pH			Redox Potential (mV)		
	Mean	Minimum	Maximum	Mean	Minimum	Maximum	Mean	Minimum	Maximum
Little Colorado River									
96-1									
96-3									
96-4									
96-5	93.21	92.0	96.5	8.98	8.9	9.2			
Shinumo Creek									
96-1	93.75	93.8	93.8	8.55	8.6	8.6	358.0	358	358
96-3									
96-4	88.75	88.8	88.8	8.57	5.3	8.9	326.0	326	327
96-5	92.45	92.5	92.5	9.45	9.5	9.5	340.0	340	340
Kanab Creek									
96-1	93.25	93.3	93.3	8.30	8.3	8.3	367.0	367	367
96-3									
96-4	86.05	86.1	86.1	8.65	8.7	8.7	337.0	337	337
96-5	91.38	91.3	94.7	9.35	9.3	9.4	307.5	295	320
Havasupai Creek									
96-1	99.43	99.4	100.3	8.40	8.4	8.4	351.0	348	354
96-3									
96-4	93.85	93.9	93.9	8.75	8.8	8.8	343.0	343	343
96-5	98.04	97.5	98.1	9.30	9.3	9.3	324.0	324	334

Appendix 11. Mean density (number / m³) and standard error (SE) of zooplankton between backwater and mainchannel habitats during AGFD Monitoring Trips 96-1, 96-3, 96-4 and 96-5 in the Colorado River, Grand Canyon, Arizona, 1996. Location refers to river miles below Lee's Ferry followed by side of river when facing downstream (L or R).

Reach	Mean	Copepoda		Copepod Nauplii		Branchiopoda		Rotifera		Total	
		Mean	SE	Mean	SE	Mean	SE	Mean	SE	Mean	SE
Trip 96-1: 28 February - 14 March											
2	44.27 L	680.0	224.5	1680.0	382.6	400.0	178.9	2440.0	530.7	5200.0	839.1
2	58.68 L	266.7	84.3	966.7	344.2	66.7	66.7	1200.0	103.3	2500.0	472.6
2	60.85 L	266.7	111.6	1366.7	348.0	0.0	0.0	1633.3	221.6	3266.7	402.2
Reach 2 Mean		388.2	89.9	1317.7	205.8	141.2	68.1	1717.7	207.3	3564.7	412.8
3	65.25 L	2033.3	989.8	1166.7	270.4	100.0	68.3	1666.7	168.7	4966.7	1305.8
4	74.06 R	200.0	103.3	233.3	95.5	0	0	1366.7	417.7	1800.0	409.9
4	74.46 R	200.0	89.4	400.0	103.3	0	0	1233.3	239.0	1833.3	298.5
Reach 4 Mean		200.0	65.1	316.7	71.6	0	0	1300.0	230.3	1816.7	241.8
6	117.40 R	133.3	84.3	300.0	85.6	100.0	68.3	1133.3	245.9	1666.7	295.2
7	165.00 L	200.0	126.5	233.3	149.8	0	0	1200.0	287.5	1633.3	394.7
8	184.48 L	100.0	68.3	66.7	42.2	0	29.0	233.3	130.8	400.0	115.5
8	192.42 R	166.7	61.5	200.0	73.0	33.3	33.3	800.0	154.9	1200.0	200.0
8	193.95 R	0	0	266.7	160.6	33.3	33.3	1266.7	418.5	1566.7	414.5
8	201.06 R	0	0	133.3	42.2	33.3	33.3	766.7	215.5	933.3	261.6
Reach 8 Mean		66.7	26.0	166.7	46.1	25.0	13.8	3.6	221.0	1025.0	154.3
Trip 96-3: 18 April - 3 May											
2	44.27 L	1233.3	355.6	3833.3	996.6	133.3	84.3	1766.7	517.5	6966.7	1822.4
2	55.50 R	600.0	200.0	3066.7	1097.5	0	0	1000.0	115.5	4666.7	1212.9

Appendix 11. continued

Reach	Location	Copepoda		Copepod Nauplii		Branchiopoda		Rotifera		Total	
		Mean	SE	Mean	SE	Mean	SE	Mean	SE	Mean	SE
Trip 96-3 continued											
2	58.68 L	733.3	229.0	1066.7	341.2	0	0	1800.0	247.7	3600.0	640.8
2	60.85 L	500.0	100.0	1300.0	295.5	66.7	66.7	1266.7	197.8	3133.3	349.0
Reach 2 Mean		790.5	135.6	2209.5	419.6	57.1	31.3	1523.8	177.0	4581.0	649.1
3	64.06 L	1200.0	186.2	3233.3	618.4	66.7	66.7	1466.7	392.2	5966.7	771.9
3	65.25 L	1083.3	216.7	2577.8	510.8	0	0	1988.9	287.7	5650.0	830.2
Reach 3 Mean		1141.7	137.3	2905.6	395.0	33.3	33.3	1727.8	244.9	5808.3	542.5
6	117.40 R	833.3	174.5	2966.7	512.3	0	0	1666.7	240.4	5466.7	770.6
7	165.00 L	466.7	143.0	200.0	73.0	0	0	933.3	133.3	2833.3	417.7
8	184.48 L	433.3	182.0	566.7	255.2	0	0	566.7	158.5	1566.7	457.3
Trip 96-4: 19 June - 4 July											
2	44.27 L	600.0	103.3	2233.3	603.1	66.7	42.2	4033.3	571.4	6933.3	1140.4
2	55.50 R	633.3	149.8	2500.0	1231.5	266.7	197.8	9500.0	5435.4	12900.0	6887.0
2	58.68 L	1000.0	357.8	1566.7	233.3	0	0	3800.0	225.1	6366.7	691.7
2	60.85 L	1566.7	624.9	2233.3	244.5	0	0	3433.3	703.2	7233.3	1311.9
Reach 2 Mean		950.0	191.2	2133.3	337.0	83.3	52.4	5191.7	1387.1	8358.3	1752.5
3	65.25 L	300.0	123.8	1166.7	182.0	33.3	33.3	4633.3	1126.0	6133.3	973.9
6	117.40 R	633.3	239.0	433.3	108.5	66.7	42.2	1833.3	250.0	2966.7	477.3
7	165.00 L	200.0	103.3	200.0	73.0	66.7	42.2	1333.3	548.1	1800.0	551.4
Reach 7 Mean		100.0	57.7	166.7	54.1	33.3	33.3	1250.0	281.9	1550.0	287.2
7	172.02 L	0	0	133.3	84.3	0	0	1166.7	215.5	1300.0	184.4

Appendix 11 continued.

Reach	Location	Copepoda		Copepod Nauplii		Branchiopoda		Rotifera		Total	
		Mean	SE	Mean	SE	Mean	SE	Mean	SE	Mean	SE
Trip 96-5: 8 - 23 September											
2	44.27 L	66.7	42.2	33.3	33.3	66.7	66.7	466.7	176.4	633.3	158.5
2	58.68 L	166.7	80.3	133.3	84.3	33.3	33.3	1600.0	263.3	1933.3	281.3
2	60.85 L	133.3	84.3	0	0	0	0	1300.0	378.6	1433.3	433.3
Reach 2 Mean		122.2	40.1	55.6	31.5	33.3	24.3	1122.2	193.5	1333.3	213.3
3	65.25 L	166.7	80.3	100.0	68.3	33.3	33.3	1100.0	246.3	1400.0	268.3
6	117.40 R	66.7	66.7	166.7	61.5	33.3	33.3	1333.3	308.4	1600.0	372.4
7	165.00 R	100.0	68.3	0	0	0	0	700.0	364.2	800.0	396.7

Appendix 12. Mean density (number / m²) of benthic invertebrates in backwaters during AGFD monitoring Trips 96-1, 96-3, 96-4 and 96-5 in the Colorado River, Grand Canyon, Arizona, 1996. Location refers to river mile below Lee's Ferry, followed by side of the river when facing downstream (L or R).

Reach	Location	Crustacea	Chiro-	Other	Mollusca	Nematoda	Oligochaeta	Misc.	Total
			nomidae	Diptera				Inverts	Invert Density
Trip 96-1: 28 February - 14 March									
2	44.27 L	2202.9	130.4	28.9	4101.5	115.9	3637.7	0	10217.4
2	58.68 L	4259.4	405.8	43.5	2971.0	16304.4	26072.5	29.0	49985.5
2	60.85 L	0	1637.7	434.8	0	333.3	2492.8	14.5	4913.0
Reach 2 Mean		2120.8	724.6	169.1	2357.5	5584.5	10734.3	14.5	21705.3
3	65.25 L	101.5	43.5	72.5	231.9	0.0	2043.5	0	2492.8
4	74.06 R	115.9	536.2	43.5	0	87.0	58.0	0	840.6
4	74.46 R	14.5	29.0	0	0	29.0	43.5	0	115.9
Reach 4 Mean		65.2	282.6	21.7	0	58.0	50.7	0	478.3
6	117.40 R	29.0	391.3	43.5	0	14.5	260.9	0	478.3
7	165.00 L	0	188.4	14.5	0	58.0	0	0	260.9
8	184.48 L	0	43.5	14.5	0	0	29.0	0	87.0
8	192.42 R	0	159.4	0.0	0	0	0	14.5	173.9
8	193.95 R	0	188.4	29.0	0	43.5	173.9	0	434.8
8	201.06 R	0	101.5	58.0	0	29.0	0.0	0	188.4
Reach 8 Mean		0	123.3	25.4	0	18.1	50.7	3.6	221.0
Trip 96-3: 18 April - 3 May									
2	44.27 L	202.9	0	0	144.9	101.5	4971.0	43.5	5463.8
2	55.50 R	0	29.0	29.0	217.4	753.6	2682.1	29.0	3884.1

Appendix 12 continued.

Reach	Location	Crustacea	Chiro- nomidae	Other Diptera	Mollusca	Nematoda	Oligochaeta	Misc. Inverts	Total Invert Density
<u>Trip 96-3 continued</u>									
2	58.68 L	0	0	0	0	304.4	13159.4	0	13463.8
2	60.85 L	14.5	101.5	0	0	231.9	188.4	14.5	550.7
Reach 2 Mean		54.5	32.6	7.3	90.6	347.8	5286.2	21.7	5840.6
3	64.06 L	14.5	14.5	87.0	0	0	0	14.5	130.4
3	65.25 L	0	14.5	0	87.0	289.9	1478.3	43.5	1913.0
Reach 3 Mean		7.3	14.5	43.5	43.5	144.9	739.1	29.0	1021.7
6	117.40 R	0	72.5	14.5	0.0	72.5	43.5	0.0	202.9
7	165.00 L	0	0	0	0	14.5	0	0	14.5
8	184.48 L	0	0	0	0	0	0	0	0
<u>Trip 96-4: 19 June - 4 July</u>									
2	44.27 L	550.7	811.6	14.5	0	101.5	5246.4	5942.0	12666.7
2	55.50 R	260.9	10492.8	72.5	594.2	1362.3	2246.4	115.9	15144.9
2	58.68 L	0	231.9	115.9	43.5	130.4	10492.8	6246.4	17260.9
2	60.85 L	0	29.0	202.9	14.5	188.4	376.8	0	811.6
Reach 2 Mean		202.9	2891.3	101.5	163.0	445.7	4590.6	3076.1	11471.0
3	65.25 L	0	202.9	1159.4	0	115.9	246.4	29.0	1753.6
6	117.40 R	0	101.5	72.5	0	29.0	144.9	0	347.8
7	165.00 L	0	826.1	6536.2	0	0	72.5	14.5	7449.3
7	172.02 L	0	1869.6	14.5	14.5	0	87.0	0	1985.5
Reach 7 Mean		0	1347.8	3275.4	7.3	0	79.7	7.3	4717.4

Appendix 12 continued.

Reach	Location	Crustacea	Chiro- nomidae	Other Diptera	Mollusca	Nematoda	Oligochaeta	Misc. Inverts	Total Invert Density
<u>Trip 96-5: 8 - 23 September</u>									
2	44.27 L	1318.8	1536.2	43.5	652.2	130.4	10710.1	1478.3	15869.6
2	58.68 L	14.5	565.2	0	449.3	159.4	4898.6	72.5	6159.4
2	60.85 L	0	0	14.5	0	14.5	434.8	14.5	478.3
Reach 2 Mean		444.4	700.5	19.3	367.2	101.5	5347.8	521.7	7502.4
3	65.25 L	188.4	318.8	2565.2	188.4	72.5	3115.9	72.5	6521.7
6	117.40 R	0	115.9	1536.2	0	72.5	347.8	173.9	2246.4
7	165.00 L	0	87.0	739.1	0	0	72.5	0	898.6

Appendix 13. Amount of collection effort expended by AGFD and number of sites in each reach and tributary using seines, electrofishing and minnow traps in the Colorado River, Grand Canyon, Arizona, during AGFD monitoring trips, 1996.

Reach/Tributary	Seines (m ²)				Electrofishing (sec)		Trammel Nets (hr)	
	Back		Main		Main		Main	
	Effort	Sites	Effort	Sites	Effort	Sites	Effort	Sites
<u>Trip 96-1</u>								
CR2	935	4	731	3			9.8	6
CR3	394	3			5525	18	19.09	10
CR4	692	5	278	2	3762	11	14.98	8
CR5							4.22	3
CR6	287	1	155	1				
CR7	813	13			801	4	7.36	4
CR8	1221	8	1654	4				
LCR							3.47	2
SHM								
KAN								
HAV								
Total	4342	34	2818	10	10088	33	58.92	33
<u>Trip 96-3</u>								
CR2	1065	4	460	3			15.98	8
CR3	626	3			7114	15	15.9	8
CR4	1458	3			4017	9	15.58	8
CR5	242	2					5.65	3
CR6	440	3	252	1				
CR7	565	6	24	1	5607	11	7.79	4
CR8	1737	10	320	1				
SHM								
KAN								
HAV								
Total	6133	31	1056	6	16738	35	60.9	31
<u>Trip 96-4</u>								
CR1	446	2						
CR2	1416	7	630	3	1144	2	13.61	8
CR3	551	4			10782	20	10.37	6

Appendix 13 continued.

Reach/Tributary	Seines (m ²)				Electrofishing (sec)		Trammel Nets (hr)	
	Back		Main		Main		Main	
	Effort	Sites	Effort	Sites	Effort	Sites	Effort	Sites
<u>Trip 96-4 continued</u>								
CR4					6820	9	14.91	9
CR5	166	3			1520	4	4.6	3
CR7	848	6	180	1	2060	5	8.51	4
CR8	448	8						
LCR			196	6				
SHM								
KAN								
HAV								
Total	3875	30	1006	10	22326	40	52	30
<u>Trip 96-5</u>								
CR1	523	4						
CR2	977	8	653	3			15.34	8
CR3	541	3			5739	12	14.75	8
CR4	238	2	100	1	3592	6	48.65	10
CR5	75	2					8.26	4
CR6	370	4	160	1			9.49	5
CR7	757	10			1856	5		
CR8	617	7						
LCR			100	2				
SHM								
KAN								
HAV								
Total	4098	40	1013	7	11187	23	96.49	35

Appendix 13 continued.

Reach/Tributary	Minnow Traps						Hoop Nets	
	(hr)						(hr)	
	Back		Main		Trib		Trib	
Reach/Tributary	Effort	Sites	Effort	Sites	Effort	Sites	Effort	Sites
Reach/Tributary	Effort	Sites	Effort	Sites	Effort	Sites	Effort	Sites
<u>Trip 96-1</u>								
CR3			581.55	24				
CR4	37.53	2	149.32	9				
CR5			44.14	3				
CR6								
CR7			57.58	4				
CR8								
LCR								
SHM					30.9	2	14.67	1
KAN					38.33	2	15.78	1
HAV					36.74	2	15.53	1
Total	37.53	2	832.59	40 0	105.97	6	45.98	3
<u>Trip 96-3</u>								
CR2	14.93	1	68.82	4				
CR3			742.25	35				
CR4			217.72	11				
CR5			54.23	4				
CR6								
CR7			118.87	8				
CR8								
SHM					28.24	2	13.98	1
KAN					60.38	4	16.77	1
HAV					28.37	2	12.83	1
Total	14.93	1	1201.89	62 0	116.99	8	43.58	3
<u>Trip 96-4</u>								
CR1								
CR2			65.56	5				
CR3			839.74	33				
CR4			156.28	10				
CR5			60.9	4				
CR7			130.81	8				

Appendix 13 continued.

Reach/Tributary	Minnow Traps						Hoop Nets	
	(hr)						(hr)	
	Back		Main		Trib		Trib	
	Effort	Sites	Effort	Sites	Effort	Sites	Effort	Sites
<u>Trip 96-4 continued</u>								
CR8								
LCR							217.99	10
SHM					26.1	2	13.07	1
KAN					60.71	4	12.05	1
HAV	-	-			<u>28.71</u>	<u>2</u>	<u>14.00</u>	<u>1</u>
Total	0	0	1253.29	60	115.52	8	257.11	13
<u>Trip 96-5</u>								
CR1								
CR2			52.47	4				
CR3			702.98	30				
CR4			146.86	9				
CR5			71.6	5				
CR6								
CR7			140.62	8				
CR8								
LCR							470.29	18
SHM					29.76	2	14.85	1
KAN					82.71	5	15.03	1
HAV	-	-			<u>28.13</u>	<u>2</u>	<u>13.83</u>	<u>1</u>
Total	0	0	1114.53	56	140.6	9	514.00	21

Appendix 14. Number of caught and catch-per-unit-effort (CPUE) for native fishes in each reach and tributary sampled in each gear type used during AGFD monitoring in the Colorado River, Grand Canyon, Arizona, 1996.

Gear/ Reach or Tributary	Bluehead Sucker		Flannemouth Sucker		Humpback Chub		Speckled Dace	
	Catch	CPUE	Catch	CPUE	Catch	CPUE	Catch	CPUE
<u>Hoop Nets (number / 12 hours)</u>								
Havasu Creek	5	3.863	32	24.726	0	0.000	0	0.000
Kanab Creek	9	6.844	1	0.760	0	0.000	4	3.042
Shinumo Creek	1	0.818	0	0.000	0	0.000	1	0.818
<u>Seines (number / 100 m²)</u>								
Reach 2	0	0.000	40	1.165	3	0.088	39	1.145
Reach 3	4	0.454	7	0.794	3	0.340	3	0.340
Reach 4	6	0.292	2	0.097	39	2.053	42	4.443
Reach 6	0	0.000	1	0.116	1	0.116	7	1.110
Reach 7	8	0.682	1	0.052	0	0.000	7	1.008
Reach 8	9	0.139	23	0.375	0	0.000	58	1.479
<u>Electrofishing (number / 10 minutes)</u>								
Reach 3	0	0.000	0	0.000	5	0.458	3	0.431
Reach 4	0	0.000	0	0.000	3	0.413	0	0.000
Reach 7	0	0.000	0	0.000	1	0.838	0	0.000
<u>Trammel Nets (number / 100 hours)</u>								
Reach 2	0	0.000	5	31.369	14	81.471	0	0.000
Reach 3	0	0.000	1	2.738	3	8.607	0	0.000
Reach 4	0	0.000	1	3.931	0	0.000	0	0.000
Reach 5	0	0.000	1	11.416	0	0.000	0	0.000
Reach 7	0	0.000	2	14.398	0	0.000	0	0.000
Little Colorado River	0	0.000	48	484.251	9	86.505	0	0.000

Trip 96-1: 28 February - 14 March 1996

Appendix 14 continued.

Gear/ Reach or Tributary	Bluehead Sucker		Flannemouth Sucker		Humpback Chub		Speckled Dace	
	Catch	CPUE	Catch	CPUE	Catch	CPUE	Catch	CPUE
<u>Minnow Traps (number / 24 hours)</u>								
<u>Trip 96-1 continued</u>								
Reach 3	1	0.008	0	0.000	5	0.042	11	0.092
Reach 4	0	0.000	0	0.000	5	0.115	0	0.000
Reach 5	0	0.000	0	0.000	1	0.109	0	0.000
Reach 7	0	0.000	0	0.000	0	0.000	0	0.000
Havasu Creek	0	0.000	0	0.000	0	0.000	22	2.887
Kanab Creek	5	0.632	1	0.126	0	0.000	2	0.253
Shinumo Creek	0	0.000	0	0.000	0	0.000	4	0.687
<u>Trip 96-3: 18 April - 3 May</u>								
<u>Hoop Nets (number / 12 hours)</u>								
Havasu Creek	3	2.806	54	50.507	0	0.000	0	0.000
Kanab Creek	11	7.871	171	122.361	0	0.000	7	5.009
Shinumo Creek	3	2.575	1	0.858	0	0.000	2	1.717
<u>Seines (number / 100 m²)</u>								
Reach 2	0	0.000	2	0.046	0	0.000	7	0.190
Reach 3	0	0.000	1	0.137	1	0.137	23	3.052
Reach 4	3	0.230	0	0.000	0	0.000	0	0.000
Reach 5	0	0.000	0	0.000	0	0.000	11	4.701
Reach 6	0	0.000	1	0.079	0	0.000	38	7.306
Reach 7	1	0.115	1	0.251	0	0.000	12	1.831
Reach 8	0	0.000	5	0.134	0	0.000	27	2.101
<u>Electrofishing (number / 10 minutes)</u>								
Reach 3	0	0.000	2	0.215	8	0.553	6	0.540

Appendix 14 continued.

Gear/ Reach or Tributary	Bluehead Sucker		Flannemouth Sucker		Humpback Chub		Speckled Dace	
	Catch	CPUE	Catch	CPUE	Catch	CPUE	Catch	CPUE
<u>Electrofishing continued</u>								
Reach 4	0	0.000	0	0.000	3	0.462	0	0.000
Reach 7	1	0.089	0	0.000	1	0.094	0	0.000
<u>Tammel Nets (number / 100 hours)</u>								
Reach 2	0	0.000	7	24.482	13	44.304	0	0.000
Reach 3	0	0.000	2	6.878	15	52.469	0	0.000
Reach 4	1	3.268	1	3.472	1	3.546	0	0.000
Reach 5	0	0.000	0	0.000	0	0.000	0	0.000
Reach 7	0	0.000	0	0.000	0	0.000	0	0.000
<u>Minnow Traps (number / 24 hours)</u>								
Reach 2	0	0.000	0	0.000	0	0.000	0	0.000
Reach 3	1	0.009	0	0.000	3	0.017	20	0.132
Reach 4	0	0.000	0	0.000	2	0.049	0	0.000
Reach 5	0	0.000	0	0.000	0	0.000	0	0.000
Reach 7	0	0.000	0	0.000	0	0.000	0	0.000
Havasu Creek	1	0.173	0	0.000	0	0.000	11	1.858
Kanab Creek	0	0.000	0	0.000	0	0.000	5	0.402
Shinumo Creek	0	0.000	0	0.000	0	0.000	10	1.700
<u>Trip 96-4: 19 June - 4 July</u>								
<u>Hoop Nets (number / 12 hours)</u>								
Havasu Creek	2	1.714	110	94.286	1	0.857	10	8.571
Kanab Creek	0	0.000	2	1.992	0	0.000	4	3.983
Little Colorado River	7	0.366	7	0.336	19	0.951	0	0.000

Appendix 14 continued.

Gear/ Reach or Tributary	Bluehead Sucker		Flannelmouth Sucker		Humpback Chub		Speckled Dace	
	Catch	CPUE	Catch	CPUE	Catch	CPUE	Catch	CPUE
Hoop Nets continued								
Shinumo Creek	0	0.000	23	21.117	3	2.754	39	35.807
Seines (number / 100 m²)								
Reach 1	0	0.000	0	0.000	0	0.000	0	0.000
Reach 2	0	0.000	57	0.687	0	0.000	33	0.906
Reach 3	75	28.691	20	7.441	25	4.167	181	61.667
Reach 4	5	0.514	3	0.309	1	0.103	23	2.366
Reach 5	0	0.000	0	0.000	0	0.000	0	0.000
Reach 7	61	12.016	214	18.315	0	0.000	73	8.376
Reach 8	21	9.656	106	31.058	0	0.000	772	324.459
Little Colorado River	53	44.042	3	2.083	7	20.139	0	0.000
Electrofishing (number / 10 minutes)								
Reach 2	0	0.000	0	0.000	0	0.000	0	0.000
Reach 3	0	0.000	0	0.000	14	0.981	1	0.045
Reach 4	1	0.085	0	0.000	6	0.476	3	0.271
Reach 5	2	0.677	7	3.194	0	0.000	0	0.000
Reach 7	0	0.000	0	0.000	0	0.000	0	0.000
Trammel Nets (number / 100 hours)								
Reach 2	0	0.000	0	0.000	3	10.800	0	0.000
Reach 3	0	0.000	1	5.807	1	4.263	0	0.000
Reach 4	0	0.000	0	0.000	0	0.000	0	0.000
Reach 5	0	0.000	0	0.000	0	0.000	0	0.000
Reach 7	0	0.000	0	0.000	0	0.000	0	0.000

Appendix 14 continued.

Gear/ Reach or Tributary	Bluehead Sucker		Flannelmouth Sucker		Humpback Chub		Speckled Dace	
	Catch	CPUE	Catch	CPUE	Catch	CPUE	Catch	CPUE
<u>Minnow Traps (number / 24 hours)</u>								
<u>Trip 96-4 continued</u>								
Reach 2	0	0.000	0	0.000	0	0.000	0	0.000
Reach 3	2	0.017	1	0.006	10	0.071	7	0.051
Reach 4	0	0.000	0	0.000	7	0.214	1	0.029
Reach 5	0	0.000	0	0.000	0	0.000	2	0.158
Reach 7	1	0.046	0	0.000	2	0.079	0	0.000
Havasu Creek	1	0.166	0	0.000	0	0.000	23	3.835
Kanab Creek	0	0.000	5	0.416	0	0.000	19	1.483
Shinumo Creek	0	0.000	0	0.000	1	0.191	14	2.603
<u>Hoop Nets (number / 12 hours)</u>								
<u>Trip 96-5: 8 - 23 September</u>								
Havasu Creek	0	0.000	27	23.427	1	0.868	2	1.735
Kanab Creek	4	3.194	6	4.790	0	0.000	8	6.387
Little Colorado River	0	0.000	0	0.000	1	0.029	1	0.029
Shinumo Creek	16	12.929	1	0.808	1	0.808	3	2.424
<u>Seines (number / 100 m²)</u>								
Reach 1	0	0.000	0	0.000	0	0.000	2	0.625
Reach 2	0	0.000	23	1.422	0	0.000	2	0.086
Reach 3	4	0.403	9	0.904	99	9.443	9	0.867
Reach 4	5	0.984	8	2.661	171	38.555	2	1.343
Reach 5	0	0.000	4	5.159	5	6.085	6	11.376
Reach 6	20	3.238	14	2.254	38	6.730	15	2.258
Reach 7	48	6.366	56	7.105	5	1.873	117	19.362

Appendix 14 continued.

Gear/ Reach or Tributary	Bluehead Sucker		Flannelmouth Sucker		Humpback Chub		Speckled Dace	
	Catch	CPUE	Catch	CPUE	Catch	CPUE	Catch	CPUE
<u>Seines continued</u>								
Reach 8	30	6.848	15	3.231	0	0.000	80	25.297
Little Colorado River	0	0.000	0	0.000	8	7.853	0	0.000
<u>Electrofishing (number / 10 minutes)</u>								
Reach 3	0	0.000	1	0.111	4	0.455	1	0.146
Reach 4	0	0.000	0	0.000	1	0.165	0	0.000
Reach 7	1	0.245	0	0.000	0	0.000	1	0.397
<u>Trammel Nets (number / 100 hours)</u>								
Reach 2	0	0.000	8	24.347	8	27.238	0	0.000
Reach 3	4	13.112	2	7.237	10	36.135	0	0.000
Reach 4	1	2.278	1	2.631	4	9.017	0	0.000
Reach 5	0	0.000	1	5.952	0	0.000	0	0.000
Reach 6	0	0.000	0	0.000	0	0.000	0	0.000
<u>Minnow Traps (number / 24 hours)</u>								
Reach 2	0	0.000	0	0.000	0	0.000	0	0.000
Reach 3	0	0.000	0	0.000	19	0.135	1	0.008
Reach 4	0	0.000	0	0.000	20	0.543	0	0.000
Reach 5	0	0.000	0	0.000	0	0.000	0	0.000
Reach 7	1	0.026	0	0.000	0	0.000	0	0.000
Havasut Creek	0	0.000	0	0.000	0	0.000	18	3.078
Kanab Creek	2	0.116	0	0.000	0	0.000	6	0.349
Shinumo Creek	8	1.281	1	0.167	18	3.004	1	0.167

Appendix 15. Number of caught and catch-per-unit-effort (CPUE) for common exotic fishes in each reach and tributary sampled in each gear type used during AGFD monitoring in the Colorado River, Grand Canyon, Arizona, 1996.

Gear/ Reach or Tributary	Common Carp		Fathead Minnow		Red Shiner		Plains Killifish		Rainbow Trout	
	Catch	CPUE	Catch	CPUE	Catch	CPUE	Catch	CPUE	Catch	CPUE
<u>Hoop Nets (number / 12 hours)</u>										
Trip 96-1: 28 February - 14 March 1996										
Havasu Creek	0	0.000	1	0.773	0	0.000	0	0.000	1	0.773
Kanab Creek	0	0.000	0	0.000	0	0.000	0	0.000	0	0.000
Shinumo Creek	0	0.000	0	0.000	0	0.000	0	0.000	3	2.454
<u>Seines (number / 100 m²)</u>										
Reach 2	3	0.082	85	2.522	0	0.000	0	0.000	6	0.144
Reach 3	0	0.000	13	2.583	0	0.000	0	0.000	0	0.000
Reach 4	5	1.381	488	43.006	0	0.000	39	2.469	1	0.192
Reach 6	0	0.000	114	19.175	0	0.000	0	0.000	0	0.000
Reach 7	1	0.086	147	17.613	0	0.000	4	0.535	0	0.000
Reach 8	3	0.062	235	5.456	0	0.000	4	0.068	0	0.000
<u>Electrofishing (number / 10 minutes)</u>										
Reach 3	1	0.114	10	0.800	0	0.000	0	0.000	30	3.091
Reach 4	0	0.000	15	3.231	0	0.000	0	0.000	21	4.101
Reach 7	1	0.655	1	0.838	0	0.000	0	0.000	1	0.761
<u>Trammel Nets (number / 100 hours)</u>										
Reach 2	0	0.000	0	0.000	0	0.000	0	0.000	13	69.724
Reach 3	0	0.000	0	0.000	0	0.000	0	0.000	5	14.336
Reach 4	0	0.000	0	0.000	0	0.000	0	0.000	9	31.494
Reach 5	1	12.346	0	0.000	0	0.000	0	0.000	0	0.000
Reach 7	0	0.000	0	0.000	0	0.000	0	0.000	0	0.000
Little Colorado River	0	0.000	0	0.000	0	0.000	0	0.000	1	8.658

Appendix 15 continued.

Gear/ Reach or Tributary	Common Carp		Fathead Minnow		Red Shiner		Plains Killifish		Rainbow Trout	
	Catch	CPUE	Catch	CPUE	Catch	CPUE	Catch	CPUE	Catch	CPUE
<u>Minnow Traps (number / 24 hours)</u>										
Trip 96-1 continued										
Reach 3	0	0.000	11	0.095	0	0.000	0	0.000	0	0.000
Reach 4	0	0.000	14	0.349	0	0.000	0	0.000	0	0.000
Reach 5	0	0.000	1	0.109	0	0.000	0	0.000	0	0.000
Reach 7	0	0.000	0	0.000	0	0.000	0	0.000	0	0.000
Havasu Creek	0	0.000	0	0.000	0	0.000	0	0.000	0	0.000
Kanab Creek	0	0.000	82	10.365	0	0.000	0	0.000	0	0.000
Shinumo Creek	0	0.000	0	0.000	0	0.000	0	0.000	0	0.000
Trip 96-3: 18 April - 3 May										
<u>Hoop Nets (number / 12 hours)</u>										
Havasu Creek	0	0.000	0	0.000	0	0.000	0	0.000	0	0.000
Kanab Creek	0	0.000	1	0.716	0	0.000	0	0.000	0	0.000
Shinumo Creek	0	0.000	1	0.858	0	0.000	0	0.000	0	0.000
<u>Seines (number / 100 m²)</u>										
Reach 2	0	0.000	2	0.048	0	0.000	0	0.000	14	1.104
Reach 3	0	0.000	73	10.028	0	0.000	0	0.000	5	0.633
Reach 4	0	0.000	4	0.307	0	0.000	0	0.000	0	0.000
Reach 5	0	0.000	17	7.265	0	0.000	0	0.000	2	0.800
Reach 6	0	0.000	0	0.000	0	0.000	0	0.000	1	0.196
Reach 7	0	0.000	46	7.673	0	0.000	0	0.000	0	0.000
Reach 8	4	0.263	24	1.747	0	0.000	0	0.000	0	0.000
<u>Electrofishing (number / 10 minutes)</u>										
Reach 3	0	0.000	2	0.290	0	0.000	0	0.000	33	3.177

Appendix 15 continued.

Gear/ Reach or Tributary	Common Carp		Fathead Minnow		Red Shiner		Plains Killifish		Rainbow Trout	
	Catch	CPUE	Catch	CPUE	Catch	CPUE	Catch	CPUE	Catch	CPUE
<u>Electrofishing continued</u>										
<u>Trip 96-3 continued</u>										
Reach 4	0	0.000	2	0.839	0	0.000	0	0.000	6	0.973
Reach 7	5	0.884	0	0.000	0	0.000	0	0.000	3	0.296
<u>Trammel Nets (number / 100 hours)</u>										
Reach 2	0	0.000	0	0.000	0	0.000	0	0.000	23	87.398
Reach 3	0	0.000	0	0.000	0	0.000	0	0.000	5	17.040
Reach 4	1	3.463	0	0.000	0	0.000	0	0.000	13	44.508
Reach 5	0	0.000	0	0.000	0	0.000	0	0.000	0	0.000
Reach 7	0	0.000	0	0.000	0	0.000	0	0.000	1	6.494
<u>Minnow Traps (number / 24 hours)</u>										
Reach 2	0	0.000	0	0.000	0	0.000	0	0.000	1	0.065
Reach 3	0	0.000	2	0.012	0	0.000	0	0.000	1	0.009
Reach 4	0	0.000	1	0.023	0	0.000	0	0.000	0	0.000
Reach 5	0	0.000	0	0.000	0	0.000	0	0.000	0	0.000
Reach 7	0	0.000	0	0.000	0	0.000	0	0.000	2	0.082
Havasü Creek	0	0.000	0	0.000	0	0.000	0	0.000	0	0.000
Kanab Creek	0	0.000	112	9.103	0	0.000	0	0.000	0	0.000
Shinumo Creek	0	0.000	1	0.170	0	0.000	0	0.000	0	0.000
<u>Trip 96-4: 19 June - 4 July</u>										
<u>Hoop Nets (number / 12 hours)</u>										
Havasü Creek	0	0.000	0	0.000	0	0.000	0	0.000	0	0.000
Kanab Creek	1	0.996	15	14.938	0	0.000	0	0.000	0	0.000
Little Colorado River	6	0.290	36	1.797	0	0.000	11	0.570	0	0.000

Appendix 15 continued.

Gear/ Reach or Tributary	Common Carp		Fathead Minnow		Red Shiner		Plains Killifish		Rainbow Trout	
	Catch	CPUE	Catch	CPUE	Catch	CPUE	Catch	CPUE	Catch	CPUE
Hoop Nets continued										
Shinumo Creek	0	0.000	10	9.181	0	0.000	0	0.000	0	0.000
Seines (number / 100 m²)										
Reach 1	0	0.000	0	0.000	0	0.000	0	0.000	0	0.000
Reach 2	0	0.000	0	0.000	0	0.000	0	0.000	11	0.393
Reach 3	9	2.321	84	22.857	0	0.000	8	1.369	0	0.000
Reach 4	0	0.000	132	13.580	0	0.000	0	0.000	0	0.000
Reach 5	0	0.000	0	0.000	0	0.000	0	0.000	0	0.000
Reach 7	0	0.000	2	0.216	0	0.000	0	0.000	0	0.000
Reach 8	2	0.528	59	24.403	0	0.000	0	0.000	0	0.000
Little Colorado River	34	23.611	590	415.890	0	0.000	29	19.690	0	0.000
Electrofishing (number / 10 minutes)										
Reach 2	0	0.000	0	0.000	0	0.000	0	0.000	23	12.003
Reach 3	0	0.000	4	0.193	0	0.000	0	0.000	46	2.838
Reach 4	4	0.398	31	2.917	0	0.000	0	0.000	28	2.655
Reach 5	0	0.000	11	2.422	0	0.000	0	0.000	6	1.851
Reach 7	0	0.000	0	0.000	0	0.000	0	0.000	3	0.781
Trammel Nets (number / 100 hours)										
Reach 2	0	0.000	0	0.000	0	0.000	0	0.000	2	8.803
Reach 3	0	0.000	0	0.000	0	0.000	0	0.000	3	14.744
Reach 4	0	0.000	0	0.000	0	0.000	0	0.000	4	14.902
Reach 5	0	0.000	0	0.000	0	0.000	0	0.000	0	0.000
Reach 7	0	0.000	0	0.000	0	0.000	0	0.000	0	0.000

Appendix 15 continued.

Gear/ Reach or Tributary	Common Carp		Fathead Minnow		Red Shiner		Plains Killifish		Rainbow Trout	
	Catch	CPUE	Catch	CPUE	Catch	CPUE	Catch	CPUE	Catch	CPUE
<u>Minnow Traps (number / 24 hours)</u>										
<u>Trip 96-4 continued</u>										
Reach 2	0	0.000	0	0.000	0	0.000	0	0.000	0	0.000
Reach 3	0	0.000	3	0.022	0	0.000	0	0.000	3	0.019
Reach 4	0	0.000	1	0.029	0	0.000	0	0.000	0	0.000
Reach 5	0	0.000	0	0.000	0	0.000	0	0.000	0	0.000
Reach 7	0	0.000	0	0.000	0	0.000	0	0.000	0	0.000
Havasu Creek	0	0.000	0	0.000	0	0.000	0	0.000	0	0.000
Kanab Creek	0	0.000	119	9.743	0	0.000	0	0.000	0	0.000
Shinumo Creek	0	0.000	3	0.571	0	0.000	0	0.000	0	0.000
<u>Trip 96-5: 8 - 23 September</u>										
<u>Hoop Nets (number / 12 hours)</u>										
Havasu Creek	0	0.000	0	0.000	0	0.000	0	0.000	0	0.000
Kanab Creek	0	0.000	6	4.790	0	0.000	0	0.000	5	3.992
Little Colorado River	1	0.023	11	0.303	0	0.000	0	0.000	0	0.000
Shinumo Creek	0	0.000	21	16.970	0	0.000	0	0.000	0	0.000
<u>Seines (number / 100 m²)</u>										
Reach 1	0	0.000	0	0.000	0	0.000	0	0.000	1	0.160
Reach 2	0	0.000	1	0.029	0	0.000	2	0.095	6	0.420
Reach 3	0	0.000	106	10.160	0	0.000	16	1.492	7	0.640
Reach 4	0	0.000	275	66.641	0	0.000	40	20.235	13	4.150
Reach 5	0	0.000	5	7.540	0	0.000	0	0.000	0	0.000
Reach 6	0	0.000	63	10.308	0	0.000	5	0.651	3	0.660
Reach 7	3	0.179	580	48.755	0	0.000	3	0.205	7	0.477

Appendix 15 continued.

Gear/ Reach or Tributary	Common Carp		Fathead Minnow		Red Shiner		Plains Killifish		Rainbow Trout	
	Catch	CPUE	Catch	CPUE	Catch	CPUE	Catch	CPUE	Catch	CPUE
Seines continued										
Reach 8	2	0.161	133	22.314	0	0.000	3	0.994	0	0.000
Little Colorado River	3	3.125	11	10.657	0	0.000	2	1.923	0	0.000
Electrofishing (number / 10 minutes)										
Reach 3	0	0.000	2	0.239	0	0.000	0	0.000	23	3.108
Reach 4	0	0.000	0	0.000	0	0.000	0	0.000	23	3.393
Reach 7	0	0.000	1	0.533	0	0.000	0	0.000	12	5.112
Trammel Nets (number / 100 hours)										
Reach 2	0	0.000	0	0.000	0	0.000	0	0.000	32	106.520
Reach 3	0	0.000	0	0.000	0	0.000	0	0.000	8	29.818
Reach 4	0	0.000	0	0.000	0	0.000	0	0.000	40	100.080
Reach 5	0	0.000	0	0.000	0	0.000	0	0.000	4	24.814
Reach 6	0	0.000	0	0.000	0	0.000	0	0.000	4	22.676
Minnow Traps (number / 24 hours)										
Reach 2	0	0.000	0	0.000	0	0.000	0	0.000	0	0.000
Reach 3	0	0.000	0	0.000	0	0.000	1	0.006	1	0.006
Reach 4	0	0.000	1	0.027	0	0.000	0	0.000	1	0.027
Reach 5	0	0.000	1	0.065	0	0.000	0	0.000	0	0.000
Reach 7	0	0.000	0	0.000	0	0.000	0	0.000	0	0.000
Havasu Creek	0	0.000	0	0.000	0	0.000	0	0.000	0	0.000
Kanab Creek	0	0.000	1	0.058	0	0.000	2	0.116	0	0.000
Shinumo Creek	0	0.000	68	11.317	0	0.000	0	0.000	0	0.000

Appendix 16. Mean, minimum, and maximum total length (mm) and weight (g) of fish caught in each reach and tributary of the Colorado River, Grand Canyon, Arizona, during AGFD Monitoring Trips 96-1, 96-3, 96-4, and 96-5, 1996.

Reach/Species	Total Length (mm)			Weight (g)		
	Mean	Minimum	Maximum	Mean	Minimum	Maximum
<u>Trip 96-1</u>						
<u>Reach 2</u>						
Flannemouth Sucker	107.2	37	442	73.52	0.4	866.0
Humpback Chub	316.6	27	460	462.22	0.2	1141.0
Speckled Dace	42.9	28	72	0.76	0.2	3.3
Common Carp	88.0	76	106	11.83	6.5	20.5
Fathead Minnow	53.5	24	78	1.86	0.1	6.2
Rainbow Trout	320.8	33	397	348.65	0.2	569.0
<u>Little Colorado River</u>						
Flannemouth Sucker	423.3	307	540	789.24	306.0	1692.0
Humpback Chub	373.3	342	395	479.17	402.0	622.0
Rainbow Trout	361.0	361	361	405.00	405.0	405.0
<u>Reach 3</u>						
Bluehead Sucker	32.6	25	46	0.34	0.1	0.9
Flannemouth Sucker	111.4	21	439	168.19	0.1	887.0
Humpback Chub	176.0	22	425	175.76	0.1	759.0
Speckled Dace	53.4	30	94	1.67	0.2	7.2
Common Carp	444.0	444	444	1113.00	1113.0	1113.0
Fathead Minnow	53.2	36	71	1.86	0.4	4.0
Rainbow Trout	317.9	167	476	341.97	50.0	1106.0
<u>Reach 4</u>						
Bluehead Sucker	46.5	35	60	0.77	0.3	1.6
Flannemouth Sucker	234.0	52	582	684.47	0.9	2050.0
Humpback Chub	46.1	22	64	0.76	0.1	2.0
Speckled Dace	38.5	19	54	0.55	0.1	1.5
Brown Trout	407.5	361	485	603.25	404.0	867.0
Common Carp	121.8	86	155	30.54	7.3	56.5
Fathead Minnow	45.4	19	74	1.12	0.1	4.6
Plains Killifish	39.8	27	70	0.64	0.1	3.4
Rainbow Trout	319.9	29	431	349.59	40.0	626.0
<u>Reach 5</u>						
Flannemouth Sucker	386.0	386	386	576.00	576.0	576.0

Appendix 16 continued.

Reach/Species	Total Length (mm)			Weight (g)		
	Mean	Minimum	Maximum	Mean	Minimum	Maximum
<u>Trip 96-1 continued</u>						
Humpback Chub	33.0	33	33	0.20	0.2	0.2
Brown Trout	281.0	281	281	196.00	196.0	196.0
Common Carp	492.0	492	492	1966.00	1966.0	1966.0
Fathead Minnow	61.0	61	61	2.40	2.4	2.4
<u>Shinumo Creek</u>						
Bluehead Sucker	232.0	232	232	138.00	138.0	138.0
Speckled Dace	45.0	31	77	1.68	0.4	4.7
Rainbow Trout	339.0	297	366	350.67	235.0	409.0
<u>Reach 6</u>						
Flannemouth Sucker	100.0	100	100	6.80	6.8	6.8
Humpback Chub	41.0	41	41	0.50	0.5	0.5
Speckled Dace	29.9	18	36	0.23	0.1	0.5
Fathead Minnow	47.3	22	77	1.17	0.1	4.2
<u>Kanab Creek</u>						
Bluehead Sucker	164.3	42	292	79.28	0.8	268.0
Flannemouth Sucker	205.0	62	348	265.60	2.2	529.0
Speckled Dace	83.3	50	100	6.48	1.3	11.0
Fathead Minnow	45.8	31	63	1.04	0.2	2.7
Green Sunfish	63.2	41	173	14.05	1.0	119.0
<u>Havasui Creek</u>						
Bluehead Sucker	258.0	225	300	171.40	90.0	241.0
Flannemouth Sucker	443.4	295	560	941.44	276.0	2069.0
Speckled Dace	68.6	46	95	3.55	1.1	9.1
Fathead Minnow	48.0	48	48	1.00	1.0	1.0
Rainbow Trout	321.0	321	321	302.00	302.0	302.0
<u>Reach 7</u>						
Bluehead Sucker	40.4	32	54	0.57	0.3	1.3
Flannemouth Sucker	180.5	28	440	253.68	0.2	901.0
Humpback Chub	125.0	125	125	16.00	16.0	16.0
Speckled Dace	33.4	21	51	0.39	0.1	1.3
Common Carp	495.0	415	575	1272.00	1090.0	1454.0
Fathead Minnow	44.4	21	74	0.96	0.1	3.9
Plains Killifish	46.2	39	55	0.90	0.4	1.3

Appendix 16 continued.

Reach/Species	Total Length (mm)			Weight (g)		
	Mean	Minimum	Maximum	Mean	Minimum	Maximum
<u>Trip 96-1 continued</u>						
<u>Reach 7 continued</u>						
Rainbow Trout	190.0	190	190	80.00	80.0	80.0
<u>Reach 8</u>						
Bluehead Sucker	50.4	41	61	1.41	0.5	2.8
Flannemouth Sucker	56.0	20	352	18.47	0.2	387.0
Speckled Dace	37.8	24	56	0.49	0.1	1.4
Common Carp	199.0	81	435	319.77	7.2	944.0
Fathead Minnow	40.0	20	76	0.84	0.1	5.6
Plains Killifish	36.8	30	41	0.45	0.1	0.7
<u>Trip 96-3</u>						
<u>Reach 2</u>						
Flannemouth Sucker	364.3	32	517	738.50	0.3	1423.0
Humpback Chub	331.2	245	395	375.23	169.0	701.0
Speckled Dace	50.5	34	70	1.51	0.3	3.6
Fathead Minnow	54.5	46	63	1.95	1.0	2.9
Rainbow Trout	167.8	26	380	140.60	0.2	476.0
<u>Reach 3</u>						
Bluehead Sucker	58.0	58	58	1.30	1.3	1.3
Flannemouth Sucker	321.6	35	470	521.86	0.3	1005.0
Humpback Chub	241.1	26	453	292.95	0.1	846.0
Speckled Dace	51.1	30	85	1.36	0.2	5.5
Brown Trout	410.5	317	504	834.00	268.0	1400.0
Fathead Minnow	42.5	26	66	0.98	0.1	3.4
Rainbow Trout	258.0	30	386	223.42	0.1	553.0
<u>Reach 4</u>						
Bluehead Sucker	100.3	28	296	73.30	0.2	292.0
Flannemouth Sucker	443.0	443	443	1007.00	1007.0	1007.0
Humpback Chub	166.8	53	412	140.70	1.0	588.0
Common Carp	305.0	305	305	574.00	574.0	574.0
Fathead Minnow	48.3	29	59	1.40	0.7	2.4
Rainbow Trout	332.4	46	432	380.53	1.0	660.0
<u>Reach 5</u>						
Speckled Dace	41.9	25	48	0.65	0.1	1.2

Appendix 16 continued.

Reach/Species	Total Length (mm)			Weight (g)		
	Mean	Minimum	Maximum	Mean	Minimum	Maximum
<u>Trip 96-3 continued</u>						
<u>Reach 5 continued</u>						
Fathead Minnow	38.6	26	48	0.59	0.1	1.2
Rainbow Trout	34.7	25	40	0.50	0.5	0.5
<u>Shinumo Creek</u>						
Bluehead Sucker	249.7	193	293	195.67	70.0	295.0
Flannelmouth Sucker	196.0	196	196	60.00	60.0	60.0
Speckled Dace	64.8	42	100	3.83	0.6	11.5
Fathead Minnow	68.5	66	71	2.90	2.5	3.3
<u>Reach 6</u>						
Flannelmouth Sucker	21.0	21	21			
Speckled Dace	42.2	27	55	0.70	0.2	1.5
Rainbow Trout	35.0	35	35	0.50	0.5	0.5
<u>Kanab Creek</u>						
Bluehead Sucker	277.5	210	344	226.18	123.0	432.0
Flannelmouth Sucker	294.5	173	481	295.14	44.0	1217.0
Speckled Dace	80.0	48	112	6.53	1.1	14.8
Fathead Minnow	52.9	42	69	1.74	0.6	4.5
<u>Havasupai Creek</u>						
Bluehead Sucker	181.0	98	229	75.58	6.3	132.0
Flannelmouth Sucker	355.1	249	521	471.50	136.0	1375.0
Speckled Dace	68.5	51	99	3.15	1.0	9.0
<u>Reach 7</u>						
Bluehead Sucker	61.5	38	85	3.45	0.5	6.4
Flannelmouth Sucker	28.0	28	28	0.10	0.1	0.1
Humpback Chub	100.0	100	100	6.70	6.7	6.7
Speckled Dace	46.0	35	64	0.85	0.3	2.1
Brown Trout	345.0	345	345	406.00	406.0	406.0
Common Carp	578.0	511	645	2165.50	1520.0	2811.0
Fathead Minnow	45.7	24	69	1.14	0.1	3.2
Rainbow Trout	165.2	56	299	98.30	1.5	258.0
<u>Reach 8</u>						
Flannelmouth Sucker	37.6	20	86	1.00	0.1	4.6
Speckled Dace	43.4	27	52	0.70	0.2	1.3

Appendix 16 continued.

Reach/Species	Total Length (mm)			Weight (g)		
	Mean	Minimum	Maximum	Mean	Minimum	Maximum
<u>Trip 96-3 continued</u>						
<u>Reach 8 continued</u>						
Common Carp	487.3	437	576	1488.50	1075.0	2219.0
Fathead Minnow	38.9	25	62	0.70	0.1	3.0
<u>Trip 96-4</u>						
<u>Reach 2</u>						
Flannemouth Sucker	40.1	6	312	42.95	0.1	327.0
Humpback Chub	354.0	305	406	423.00	218.0	617.0
Speckled Dace	46.2	17	78	1.15	0.2	3.8
Rainbow Trout	242.1	35	425	247.80	0.2	695.0
<u>Little Colorado River</u>						
Bluehead Sucker	58.5	29	192	2.69	0.1	76.6
Flannemouth Sucker	66.3	42	80	2.72	0.5	6.0
Humpback Chub	55.5	23	140	2.13	0.1	22.1
Channel Catfish	600.0	374	741	2347.20	456.0	4545.0
Common Carp	60.1	22	577	3.81	0.1	99.0
Fathead Minnow	40.9	10	80	1.23	0.1	5.6
Plains Killifish	27.0	16	61	0.24	0.1	2.9
<u>Reach 3</u>						
Bluehead Sucker	53.1	16	75	1.27	0.1	3.1
Flannemouth Sucker	63.5	21	360	22.30	0.1	430.0
Humpback Chub	74.5	23	395	21.77	0.1	632.0
Speckled Dace	54.7	15	90	1.42	0.1	5.6
Brown Trout	432.0	432	432			
Common Carp	57.4	24	79	5.17	1.5	8.0
Fathead Minnow	45.5	16	69	1.29	0.1	4.0
Plains Killifish	25.0	17	32	0.28	0.2	0.5
Rainbow Trout	321.7	75	412	351.06	4.1	655.0
Red Shiner	45.0	36	51	0.93	0.3	1.3
<u>Reach 4</u>						
Bluehead Sucker	54.5	22	84	2.32	0.7	4.8
Flannemouth Sucker	37.3	30	51	0.60	0.2	1.3
Humpback Chub	81.9	42	150	5.09	0.4	24.7
Speckled Dace	68.9	51	86	2.88	0.9	5.8

Appendix 16 continued.

Reach/Species	Total Length (mm)			Weight (g)		
	Mean	Minimum	Maximum	Mean	Minimum	Maximum
<u>Trip 96-4 continued</u>						
<u>Reach 4 continued</u>						
Brown Trout	375.5	352	399	519.00	384.0	654.0
Common Carp	414.0	195	654	1911.00	145.0	4300.0
Fathead Minnow	28.1	15	67	1.62	0.2	3.9
Rainbow Trout	338.4	83	411	427.90	12.6	681.0
Red Shiner	51.5	51	52	1.45	1.4	1.5
<u>Reach 5</u>						
Bluehead Sucker	145.5	50	241	64.55	1.1	128.0
Flannelmouth Sucker	384.1	315	433	629.57	343.0	933.0
Speckled Dace	55.0	43	67	2.00	1.2	2.8
Fathead Minnow	49.2	42	57	1.48	0.9	2.0
Rainbow Trout	264.8	93	373	259.03	8.2	467.0
<u>Shinumo Creek</u>						
Flannelmouth Sucker	196.5	43	414	231.81	0.6	804.0
Humpback Chub	72.5	53	102	3.58	1.4	7.7
Speckled Dace	48.9	24	92	1.33	0.3	7.0
Fathead Minnow	58.3	50	68	2.22	1.0	3.5
<u>Reach 6</u>						
Flannelmouth Sucker	32.0	32	32	1.00	1.0	1.0
<u>Kanab Creek</u>						
Flannelmouth Sucker	93.3	42	244	16.43	0.6	90.0
Speckled Dace	38.7	29	62	0.49	0.2	1.8
Common Carp	478.0	478	478	1282.00	1282.0	1282.0
Fathead Minnow	48.5	20	72	1.34	0.1	3.5
<u>Havasu Creek</u>						
Bluehead Sucker	129.7	86	196	28.87	5.0	73.0
Flannelmouth Sucker	317.5	70	531	399.84	2.0	1380.0
Humpback Chub	211.0	211	211	104.00	104.0	104.0
Speckled Dace	72.2	43	126	3.75	0.6	14.0
<u>Reach 7</u>						
Bluehead Sucker	26.6	18	52	0.16	0.1	0.9
Flannelmouth Sucker	25.8	15	57	0.17	0.1	1.2
Humpback Chub	85.0	63	107	6.15	2.0	10.3

Appendix 16 continued.

Reach/Species	Total Length (mm)			Weight (g)		
	Mean	Minimum	Maximum	Mean	Minimum	Maximum
<u>Trip 96-4 continued</u>						
<u>Reach 7 continued</u>						
Speckled Dace	23.0	12	68	0.27	0.1	2.1
Fathead Minnow	59.0	57	61	2.05	1.7	2.4
Rainbow Trout	196.3	135	295	103.40	32.4	231.0
<u>Reach 8</u>						
Bluehead Sucker	28.0	16	42	0.38	0.2	0.8
Common Carp	395.5	349	442	1155.00	808.0	1502.0
Fathead Minnow	28.9	16	48	0.68	0.4	1.2
Flannemouth Sucker	31.8	17	52	0.46	0.1	1.2
Speckled Dace	26.5	12	60	0.47	0.1	1.6
<u>Trip 96-5</u>						
<u>Reach 1</u>						
Speckled Dace	51.0	51	51	1.00	0.8	1.2
Rainbow Trout	385.0	385	385	510.00	510.0	510.0
<u>Reach 2</u>						
Flannemouth Sucker	136.6	17	575	543.98	0.1	1885.0
Humpback Chub	376.8	269	445	522.63	205.0	955.0
Speckled Dace	50.5	36	65	1.05	0.3	1.8
Fathead Minnow	54.0	54	54	1.70	1.7	1.7
Plains Killifish	45.5	45	46	1.00	1.0	1.0
Rainbow Trout	346.1	191	415	404.47	90.0	807.0
<u>Little Colorado River</u>						
Humpback Chub	60.2	42	92	1.49	0.4	4.4
Speckled Dace	87.0	87	87	5.00	5.0	5.0
Common Carp	134.0	56	225	50.03	2.3	158.5
Fathead Minnow	41.6	12	73	1.18	0.1	39.0
Plains Killifish	42.3	29	58	0.74	0.2	1.5
Red Shiner	42.0	22	66	1.00	0.1	5.0
<u>Reach 3</u>						
Bluehead Sucker	77.6	22	215	30.83	0.7	120.0
Flannemouth Sucker	131.1	25	452	154.40	0.6	922.0
Humpback Chub	98.0	35	381	33.33	0.3	676.0
Speckled Dace	50.4	32	89	1.27	0.2	6.2

Appendix 16 continued.

Reach/Species	Total Length (mm)			Weight (g)		
	Mean	Minimum	Maximum	Mean	Minimum	Maximum
<u>Trip 96-5 continued</u>						
<u>Reach 3 continued</u>						
Brown Trout	475.5	451	500	1442.00	1176.0	1708.0
Fathead Minnow	43.9	22	70	1.08	0.1	4.3
Plains Killifish	36.8	25	52	0.61	0.2	1.4
Rainbow Trout	328.0	77	415	339.09	4.8	606.0
<u>Reach 4</u>						
Bluehead Sucker	84.8	40	245	34.42	0.6	167.0
Flannelmouth Sucker	126.9	46	438	120.98	0.7	974.0
Humpback Chub	93.8	32	429	23.07	0.2	850.0
Speckled Dace	53.5	53	54	1.35	1.3	1.4
Fathead Minnow	47.9	22	80	1.40	0.1	5.7
Plains Killifish	36.3	24	63	0.60	0.1	2.8
Rainbow Trout	337.5	150	442	377.25	34.0	761.0
Red Shiner	50.7	45	60	1.53	0.7	2.6
<u>Reach 5</u>						
Flannelmouth Sucker	211.8	60	389	219.22	1.6	601.0
Humpback Chub	87.6	52	109	6.12	0.8	10.3
Speckled Dace	44.7	30	78	1.13	0.2	3.8
Fathead Minnow	48.7	38	60	1.17	0.3	2.3
Rainbow Trout	289.5	205	384	318.50	94.0	581.0
<u>Shinumo Creek</u>						
Bluehead Sucker	86.3	53	322	35.05	1.1	542.0
Flannelmouth Sucker	218.0	78	358	213.70	4.4	423.0
Humpback Chub	78.9	59	101	3.93	1.3	8.5
Speckled Dace	65.8	62	69	2.25	1.7	2.7
Fathead Minnow	53.1	41	69	1.30	0.7	2.8
<u>Reach 6</u>						
Bluehead Sucker	67.3	22	249	17.62	0.1	226.0
Flannelmouth Sucker	117.6	25	370	75.91	0.1	520.0
Humpback Chub	91.9	38	233	12.38	0.6	131.0
Speckled Dace	49.1	21	76	1.44	0.2	3.3
Fathead Minnow	44.1	18	70	1.09	0.1	4.4
Plains Killifish	30.4	25	38	0.22	0.1	0.4

Appendix 16 continued.

Reach/Species	Total Length (mm)			Weight (g)		
	Mean	Minimum	Maximum	Mean	Minimum	Maximum
<u>Trip 96-5 continued</u>						
<u>Reach 6 continued</u>						
Rainbow Trout	263.6	209	362	204.86	74.0	432.0
Red Shiner	42.3	39	44	0.63	0.4	0.8
<u>Kanab Creek</u>						
Bluehead Sucker	145.5	66	232	52.00	2.3	134.0
Flannelmouth Sucker	102.8	69	219	36.63	3.2	198.0
Speckled Dace	60.4	40	113	3.07	0.6	14.6
Fathead Minnow	54.5	49	60	1.72	1.3	2.5
Green Sunfish	38.0	31	45	1.40	0.4	2.4
Plains Killifish	50.5	49	52	1.45	1.4	1.5
Rainbow Trout	238.0	189	381	143.20	70.0	404.0
<u>Havasu Creek</u>						
Flannelmouth Sucker	413.1	235	490	726.26	110.0	1168.0
Humpback Chub	383.0	383	383	710.00	710.0	710.0
Speckled Dace	68.3	45	97	2.39	0.8	5.3
<u>Reach 7</u>						
Bluehead Sucker	50.3	31	145	1.58	0.2	25.4
Flannelmouth Sucker	63.0	21	233	9.44	0.1	112.0
Humpback Chub	106.0	78	139	11.00	4.3	21.2
Speckled Dace	40.9	23	76	0.62	0.1	3.6
Common Carp	166.3	112	225	94.50	22.5	193.0
Fathead Minnow	42.9	18	72	1.29	0.1	4.7
Green Sunfish	60.5	36	85	5.05	0.6	9.5
Plains Killifish	33.0	25	49	0.70	0.2	1.2
Rainbow Trout	221.0	142	365	142.48	27.2	408.0
Red Shiner	56.0	54	58	1.70	1.6	1.9
Yellow Bullhead	165.0	165	165	180.00	180.0	180.0
<u>Reach 8</u>						
Bluehead Sucker	49.6	26	78	1.27	0.2	3.4
Flannelmouth Sucker	49.8	32	62	0.90	0.2	1.7
Speckled Dace	41.0	17	55	0.58	0.2	1.4
Common Carp	77.0	60	94	6.20	2.8	9.6
Fathead Minnow	49.1	24	71	1.71	0.1	4.7

Appendix 16 continued.

Reach/Species	Total Length (mm)			Weight (g)		
	Mean	Minimum	Maximum	Mean	Minimum	Maximum
<u>Trip 96-5 continued</u>						
<u>Reach 8 continued</u>						
Green Sunfish	97.0	97	97	14.40	14.4	14.4
Plains Killifish	27.0	21	33	.	.	.
Red Shiner	57.0	57	57	1.20	1.2	1.2

Appendix 17. Total length (mm), weight (g), location (river mile or tributary) and date of capture, and PIT tag number of all fish implanted with a PIT tag in the Colorado River and tributaries, Grand Canyon, Arizona, during AGFD monitoring trips, 1996.

Study	PIT Tag Number	Date	Location	Total Length	Weight	Sex
Bluehead Sucker						
3961105	1F5B08542A	5 MAR 96	SHM	232	138	U
3961130	1F7A756A08	7 MAR 96	KAN	181	56	U
3961130	1F780A0F50	7 MAR 96	KAN	198	73	U
3961130	1F782F3505	7 MAR 96	KAN	205	78	U
3961130	1F7B07540B	7 MAR 96	KAN	216	107	U
3961130	1F7839260A	7 MAR 96	KAN	211	86	U
3961130	1F7A707A7D	7 MAR 96	KAN	242	103	U
3961130	1F78402306	7 MAR 96	KAN	244	145	U
3961130	1F777B5E11	7 MAR 96	KAN	255	187	U
3961130	1F78124710	7 MAR 96	KAN	292	268	U
3961134	1F7B15450C	8 MAR 96	HAV	225	90	M
3961134	1F78014C1C	8 MAR 96	HAV	245	165	U
3961134	1F7B64384A	8 MAR 96	HAV	258	186	U
3961134	1F7A292519	8 MAR 96	HAV	262	175	U
3961134	1F7B137958	8 MAR 96	HAV	300	241	M
3963206	1F7A3D6545	23 APR 96	74.43	296	292	U
3963414	1F78255A6A	24 APR 96	SHM	193	70	U
3963414	1F783D2F7D	24 APR 96	SHM	263	222	U
3963414	1F7A3A4D60	24 APR 96	SHM	293	295	U
3963427	1F782D3507	29 APR 96	KAN	210	123	U
3963427	1F7A275D63	29 APR 96	KAN	241	136	M
3963427	1F7823596D	29 APR 96	KAN	253	155	M
3963427	1F7A1F6464	29 APR 96	KAN	267	169	M
3963427	1F7B50781E	29 APR 96	KAN	276	204	M
3963427	1F77754035	29 APR 96	KAN	286	218	F
3963427	1F7B694D28	29 APR 96	KAN	304	287	F
3963427	1F782A6D52	29 APR 96	KAN	301	272	F
3963427	1F7A1D3A10	29 APR 96	KAN	330	345	F
3963427	1F7B670B74	29 APR 96	KAN	344	432	F
3963433	7F7A167129	27 APR 96	HAV	172	59	U
3963433	7F7B1A005D	27 APR 96	HAV	225	105	U
3963433	1F3C23671B	27 APR 96	HAV	229	132	U

Appendix 17 continued.

Study	PIT Tag Number	Date	Location	Total Length	Weight	Sex
<u>Bluehead Sucker continued</u>						
3964233	1F787C006D	25 JUN 96	108.60	241	128	U
3964444	1F7834041B	22 JUN 96	260.00	192	76.6	M
3964481	1F7B663749	28 JUN 96	HAV	196	73	U
3965209	1F78013830	10 SEP 96	62.40	203	106	U
3965209	1F5C3B4703	10 SEP 96	62.40	219	104	U
3965209	1F78426443	10 SEP 96	62.40	239	155	U
3965213	1F7A7A204D	11 SEP 96	65.25	215	120	U
3965217	1F78173F13	12 SEP 96	68.46	245	167	U
3965469	1F78140154	14 SEP 96	SHM	153	145	U
3965469	1F782B4D71	14 SEP 96	SHM	215	106	F
3965469	1F7B514154	14 SEP 96	SHM	322	542	F
3965030	1F77733E39	15 SEP 96	122.02	191	82	U
3965030	1F7B66354B	15 SEP 96	122.02	249	226	U
3965480	1F7B4D5D3C	16 SEP 96	143.50	154	29.8	U
3965480	1F7A2E6B4E	16 SEP 96	143.50	229	131	U
3965480	1F7817064C	16 SEP 96	143.50	232	134	U
<u>Flannelmouth Sucker</u>						
3961005	1F7A7F1048	29 FEB 96	44.27	243	135	U
3961028	1F7B5F483F	1 MAR 96	61.50	390	626	F
3961028	1F7B515045	1 MAR 96	61.50	349	414	U
3961028	1F7806540F	1 MAR 96	61.50	369	519	F
3961028	1F7A424D58	1 MAR 96	61.50	366	493	U
3961028	1F7B030261	1 MAR 96	61.50	376	598	U
3961028	1F7B515C39	1 MAR 96	61.50	383	581	U
3961028	1F7A7C717A	1 MAR 96	61.50	380	562	U
3961028	1F7A333301	1 MAR 96	61.50	386	540	U
3961028	1F78404C5D	1 MAR 96	61.50	385	614	U
3961028	1F783F7337	1 MAR 96	61.50	387	650	U
3961028	1F77781A58	1 MAR 96	61.50	383	553	U
3961028	1F7B5E0F79	1 MAR 96	61.50	402	617	
3961028	1F7B697508	1 MAR 96	61.50	402	604	U
3961028	1F7B4A712B	1 MAR 96	61.50	400	639	U
3961028	1F77752154	1 MAR 96	61.50	402	630	U
3961028	1F7B581579	1 MAR 96	61.50	406	653	U

Appendix 17 continued.

Study	PIT Tag Number	Date	Location	Total Length	Weight	Sex
<u>Flannemouth Sucker continued</u>						
3961028	1F787B0B63	1 MAR 96	61.50	401	597	U
3961028	1F780F5604	1 MAR 96	61.50	414	780	U
3961028	1F77712752	1 MAR 96	61.50	411	665	U
3961028	1F7B687707	1 MAR 96	61.50	425	726	F
3961028	1F7B4F6A2D	1 MAR 96	61.50	438	998	U
3961028	1F7A796806	1 MAR 96	61.50	440	814	M
3961028	1F7B512075	1 MAR 96	61.50	458	942	U
3961028	1F78202A1F	1 MAR 96	61.50	488	1107	U
3961028	1F7A36AFAD	1 MAR 96	61.50	502	1082	U
3961028	1F7A2F684D	1 MAR 96	61.50	535	1470	F
3961028	1F7A3D4268	1 MAR 96	61.50	538	1440	F
3961031	1F78383100	1 MAR 96	60.85	397	717	U
3961047	1F7B132D26	2 MAR 96	61.50	307	306	M
3961047	1F7B6E4434	2 MAR 96	61.50	392	582	F
3961047	1F7837476B	2 MAR 96	61.50	390	641	M
3961047	1F7A2D3802	2 MAR 96	61.50	414	700	F
3961047	1F7B031C47	2 MAR 96	61.50	431	724	M
3961047	1F78251430	2 MAR 96	61.50	451	1044	M
3961049	1F780A233C	2 MAR 96	60.85	390	697	F
3961049	1F7A2B2E0E	2 MAR 96	60.85	442	866	F
3961112	1F7828152C	5 MAR 96	108.52	386	576	M
3961119	1F7A394965	6 MAR 96	126.78	440	901	M
3961134	1F77763143	8 MAR 96	HAV	295	276	U
3961134	1F7B126B69	8 MAR 96	HAV	326	323	U
3961134	1F78164F04	8 MAR 96	HAV	370	530	U
3961134	1F7A357141	8 MAR 96	HAV	370	471	U
3961134	1F7B055908	8 MAR 96	HAV	390	587	U
3961134	1F78791D53	8 MAR 96	HAV	390	556	U
3961130	1F7B117B5A	7 MAR 96	KAN	348	529	U
3961134	1F7A22053B	8 MAR 96	HAV	410	688	U
3961134	1F7B6B4833	8 MAR 96	HAV	415	680	M
3961134	1F7828340D	8 MAR 96	HAV	421	759	M
3961134	1F7A254F73	8 MAR 96	HAV	436	740	U
3961134	1F7A266061	8 MAR 96	HAV	430	770	M

Appendix 17 continued.

Study	PIT Tag Number	Date	Location	Total Length	Weight	Sex
<u>Flannelmouth Sucker continued</u>						
3961121	1F7B066B75	6 MAR 96	126.16	214	113	F
3961134	1F7B003C2A	8 MAR 96	HAV	440	1090	U
3961134	1F777F5516	8 MAR 96	HAV	441	896	M
3961134	1F78312216	8 MAR 96	HAV	440	944	M
3961134	1F78003F2A	8 MAR 96	HAV	440	811	U
3961134	1F7B624044	8 MAR 96	HAV	495	1190	U
3961134	1F78127463	8 MAR 96	HAV	500	1188	M
3961134	1F7A75333F	8 MAR 96	HAV	500	1155	M
3961134	1F780E3724	8 MAR 96	HAV	519	1335	U
3961134	1F777C717D	8 MAR 96	HAV	510	1118	U
3961134	1F7B4E4751	8 MAR 96	HAV	516	1282	M
3961134	1F7A38240B	8 MAR 96	HAV	522	1756	U
3961134	AF7A352210	8 MAR 96	HAV	545	1702	U
3961134	1F7B166064	8 MAR 96	HAV	560	1605	U
3961153	1F7B500F07	11 MAR 96	192.42	352	387	U
3962115	1F7B017F66	26 MAR 96	183.30	236	122	U
3962115	1F7A203215	26 MAR 96	183.30	253	182	U
3962118	7F7A167158	28 MAR 96	182.90	290	236	U
3962118	1F7B564749	28 MAR 96	182.90	302	288	U
3962118	1F7A725A1B	28 MAR 96	182.90	365	489	U
3962118	1F7B534E45	28 MAR 96	182.90	384	414	U
3962119	1F7B142B27	29 MAR 96	182.50	367	617	U
3962125	1F7B6A700C	30 MAR 96	188.20	181	54	U
3962125	1F7A305C5B	30 MAR 96	188.20	199	95	U
3962126	1F7B0C4119	30 MAR 96	186.30	264	222	U
3962131	1F7B6A700C	30 MAR 96	188.10	181	54	U
3962140	1F7A76026F	5 APR 96	183.50	381	543	U
3962144	1F7B530013	6 APR 96	182.49	191	72	U
3962144	1F7B086876	6 APR 96	182.49	316	312	U
3962144	1F7A78D721	6 APR 96	182.49	410	768	U
3963004	1F782A2916	18 APR 96	30.69	396	640	F
3963025	1F78044C19	19 APR 96	64.52	343	449	U
3963026	1F7A77036D	19 APR 96	64.30	355	503	U
3963061	1F780D7468	21 APR 96	61.15	424	834	U

Appendix 17 continued.

Study	PIT Tag Number	Date	Location	Total Length	Weight	Sex
<u>Flannelmouth Sucker continued</u>						
3962131	1F7A305C5B	30 MAR 96	188.10	199	95	U
3962134	1F7B123321	1 APR 96	182.30	366	464	U
3962140	1F7A27241C	5 APR 96	183.50	318	291	U
3963063	1F7A2D2218	21 APR 96	60.83	461	992	U
3963066	7F7A136161	21 APR 96	63.40	470	1005	F
3963414	1F77751362	24 APR 96	SHM	196	60	U
3963427	1F7B005B0B	26 APR 96	KAN	176	49	U
3963427	1F7837773B	26 APR 96	KAN	173	44	U
3963427	1F78245372	26 APR 96	KAN	181	63	M
3963427	1F7B63473C	26 APR 96	KAN	182	57	U
3963427	1F7B082737	26 APR 96	KAN	187	66	U
3963427	1F7A7F0D5B	26 APR 96	KAN	186	65	U
3963427	1F5B0A4933	26 APR 96	KAN	188	62	U
3963427	1F7B0A3329	26 APR 96	KAN	189	65	U
3963427	1F77731463	26 APR 96	KAN	185	73	U
3963427	1F7B501D79	26 APR 96	KAN	198	75	U
3963427	1F78016701	26 APR 96	KAN	194	75	U
3963427	1F78202623	26 APR 96	KAN	190	62	U
3963427	1F7B024F15	26 APR 96	KAN	190	69	U
3963427	1F78406940	26 APR 96	KAN	194	68	U
3963427	1F7B5F1C6B	26 APR 96	KAN	194	68	U
3963427	1F78316454	26 APR 96	KAN	191	63	U
3963427	1F781B5B73	26 APR 96	KAN	192	65	U
3963427	1F77712C4D	26 APR 96	KAN	201	83	U
3963427	1F7A75234F	26 APR 96	KAN	209	82	U
3963427	1F782F6159	26 APR 96	KAN	201	79	U
3963427	1F7A75383A	26 APR 96	KAN	215	99	M
3963427	1F782D5369	26 APR 96	KAN	219	93	M
3963427	1F7A20281F	26 APR 96	KAN	219	105	F
3963427	1F7B55050C	26 APR 96	KAN	218	101	U
3963427	1F78003336	26 APR 96	KAN	213	95	U
3963427	1F7B4E4F49	26 APR 96	KAN	211	99	U
3963427	1F7A7D7377	26 APR 96	KAN	220	107	U
3963427	1F7808471A	26 APR 96	KAN	220	95	U

Appendix 17 continued.

Study	PIT Tag Number	Date	Location	Total Length	Weight	Sex
<u>Flannelmouth Sucker continued</u>						
3963427	1F6B34271B	26 APR 96	KAN	221	102	U
3963427	1F7A242122	26 APR 96	KAN	236	147	U
3963427	1F78440322	26 APR 96	KAN	233	118	U
3963427	1F7B56355B	26 APR 96	KAN	231	123	U
3963427	1F7A3E0C1D	26 APR 96	KAN	237	136	U
3963427	1F7A2D704A	26 APR 96	KAN	231	125	U
3963427	1F7B51771E	26 APR 96	KAN	237	126	U
3963427	1F78085C05	26 APR 96	KAN	246	127	F
3963427	1F783A604F	26 APR 96	KAN	246	155	U
3963427	1F7B04174B	26 APR 96	KAN	249	161	U
3963427	1F7B027D67	26 APR 96	KAN	248	164	U
3963427	1F7808372A	26 APR 96	KAN	246	147	U
3963427	1F7B531F74	26 APR 96	KAN	247	141	U
3963427	1F7B586E20	26 APR 96	KAN	242	161	U
3963427	1F5B1E2543	26 APR 96	KAN	255	159	U
3963427	1F7828536E	26 APR 96	KAN	254	163	U
3963427	1F77710970	26 APR 96	KAN	250	148	U
3963427	1F7A784E21	26 APR 96	KAN	259	186	M
3963427	1F7829013F	26 APR 96	KAN	251	143	F
3963427	1F7A726B0A	26 APR 96	KAN	258	165	U
3963427	1F77702951	26 APR 96	KAN	250	159	U
3963427	1F78035B0B	26 APR 96	KAN	250	175	U
3963427	1F7777452E	26 APR 96	KAN	253	158	U
3963427	1F77745A1C	26 APR 96	KAN	252	163	U
3963427	1F7A7D5C0E	26 APR 96	KAN	260	172	M
3963427	1F78244401	26 APR 96	KAN	261	164	F
3963427	1F7A2A4974	26 APR 96	KAN	263	194	U
3963427	1F77724B2D	26 APR 96	KAN	267	194	U
3963427	1F7A23063E	26 APR 96	KAN	268	195	M
3963427	1F78373D75	26 APR 96	KAN	268	193	M
3963427	1F77780F63	26 APR 96	KAN	262	162	M
3963427	1F78007C6A	26 APR 96	KAN	267	207	F
3963427	1F7B071649	26 APR 96	KAN	260	191	F
3963427	1F7A3F2E7A	26 APR 96	KAN	263	213	F

Appendix 17 continued.

Study	PIT Tag Number	Date	Location	Total Length	Weight	Sex
<u>Flannelmouth Sucker continued</u>						
3963427	1F777E6F7D	26 APR 96	KAN	275	222	M
3963427	1F7839012F	26 APR 96	KAN	274	227	U
3963427	1F7A323C79	26 APR 96	KAN	272	210	U
3963427	1F78011B4D	26 APR 96	KAN	271	179	F
3963427	1F7A2A211C	26 APR 96	KAN	273	179	F
3963427	1F7B592667	26 APR 96	KAN	273	201	F
3963427	1F7B553859	26 APR 96	KAN	274	206	U
3963427	1F7B647012	26 APR 96	KAN	270	203	U
3963427	1F7B190A43	26 APR 96	KAN	284	208	U
3963427	1F7A716412	26 APR 96	KAN	282	219	M
3963427	1F7A271030	26 APR 96	KAN	285	240	F
3963427	1F7B555F32	26 APR 96	KAN	283	229	F
3963427	1F782E516A	26 APR 96	KAN	272	215	U
3963427	1F7B57315E	26 APR 96	KAN	281	238	U
3963427	1F780B0658	26 APR 96	KAN	281	200	F
3963427	1F78422B7C	26 APR 96	KAN	282	208	F
3963427	1F7A346152	26 APR 96	KAN	290	221	U
3963427	1F78797900	26 APR 96	KAN	291	236	F
3963427	1F7A757B77	26 APR 96	KAN	292	234	F
3963427	1F7A2D3109	26 APR 96	KAN	290	266	F
3963427	1F7B585A34	26 APR 96	KAN	292	231	F
3963427	1F7B503C5A	26 APR 96	KAN	300	262	F
3963427	1F7B5F285F	26 APR 96	KAN	309	297	M
3963427	1F7B67433C	26 APR 96	KAN	304	289	U
3963427	1F7B131241	26 APR 96	KAN	302	264	M
3963427	1F7B065A06	26 APR 96	KAN	306	262	U
3963427	1F79017176	26 APR 96	KAN	306	300	U
3963427	1F78732254	26 APR 96	KAN	306	272	F
3963427	1F7B643C46	26 APR 96	KAN	306	277	F
3963427	1F7B685F1F	26 APR 96	KAN	309	328	F
3963427	1F78326552	26 APR 96	KAN	306	273	F
3963427	1F7A260B36	26 APR 96	KAN	303	292	M
3963427	1F7A281F20	26 APR 96	KAN	302	268	F
3963427	1F78267A49	26 APR 96	KAN	302	243	F

Appendix 17 continued.

Study	PIT Tag Number	Date	Location	Total Length	Weight	Sex
<u>Flannelmouth Sucker continued</u>						
3963427	1F7B465050	26 APR 96	KAN	302	276	F
3963427	1F783A4966	26 APR 96	KAN	319	363	U
3963427	1F78004326	26 APR 96	KAN	311	311	F
3963427	1F78256B59	26 APR 96	KAN	315	311	U
3963427	1F7A780A65	26 APR 96	KAN	316	318	F
3963427	1F7A3A2706	26 APR 96	KAN	317	289	M
3963427	1F780B7A64	26 APR 96	KAN	319	335	M
3963427	1F7A242320	26 APR 96	KAN	317	286	F
3963427	1F7B53593A	26 APR 96	KAN	312	348	F
3963427	1F78261E25	26 APR 96	KAN	311	342	M
3963427	1F7776787C	26 APR 96	KAN	319	296	M
3963427	1F78235175	26 APR 96	KAN	322	338	F
3963427	1F78036F77	26 APR 96	KAN	323	327	F
3963427	1F7777472C	26 APR 96	KAN	321	264	F
3963427	1F7815785C	26 APR 96	KAN	326	349	F
3963427	1F78244302	26 APR 96	KAN	322	335	F
3963427	1F7B153E13	26 APR 96	KAN	327	316	F
3963427	1F7A1E6564	26 APR 96	KAN	329	322	F
3963427	1F7B4B7328	26 APR 96	KAN	326	361	F
3963427	1F783C327B	26 APR 96	KAN	334	445	F
3963427	1F783D0F1D	26 APR 96	KAN	338	352	F
3963427	1F7B4C2D6D	26 APR 96	KAN	331	384	F
3963427	1F7A373B75	26 APR 96	KAN	338	360	F
3963427	1F7A711E58	26 APR 96	KAN	337	357	F
3963427	1F7A3A4E5F	26 APR 96	KAN	348	433	F
3963427	1F7A344F64	26 APR 96	KAN	349	406	F
3963427	1F780F2730	26 APR 96	KAN	342	398	F
3963427	1F7B011055	26 APR 96	KAN	341	405	F
3963427	1F77766D07	26 APR 96	KAN	352	429	F
3963427	1F7B63463D	26 APR 96	KAN	353	416	F
3963427	1F7A3A3875	26 APR 96	KAN	356	464	F
3963427	1F7B041949	26 APR 96	KAN	350	429	F
3963427	1F7A35072B	26 APR 96	KAN	352	429	F
3963427	1F7B5F0E79	26 APR 96	KAN	359	427	F

Appendix 17 continued.

Study	PIT Tag Number	Date	Location	Total Length	Weight	Sex
<u>Flannelmouth Sucker continued</u>						
3963427	1F7B5C5D2D	26 APR 96	KAN	363	439	U
3963427	1F79022D39	26 APR 96	KAN	362	508	F
3963427	1F7B19133A	26 APR 96	KAN	368	495	F
3963427	1F7B154809	26 APR 96	KAN	369	496	F
3963427	1F7B111540	26 APR 96	KAN	362	530	F
3963427	1F7B10785E	26 APR 96	KAN	366	549	F
3963427	1F7A326C49	26 APR 96	KAN	369	493	F
3963427	1F7B693746	26 APR 96	KAN	375	577	M
3963427	1F7B125400	26 APR 96	KAN	377	524	F
3963427	1F78326651	26 APR 96	KAN	370	461	F
3963427	1F7A286E51	26 APR 96	KAN	380	574	F
3963427	1F7828437E	26 APR 96	KAN	389	731	F
3963427	1F7A1B616B	26 APR 96	KAN	381	494	F
3963427	1F783C4667	26 APR 96	KAN	392	640	M
3963427	1F7A7E6603	26 APR 96	KAN	397	577	M
3963427	1F781E5D6E	26 APR 96	KAN	407	741	F
3963427	1F79032342	26 APR 96	KAN	408	641	M
3963427	1F7842091E	26 APR 96	KAN	401	538	F
3963427	1F7276442F	26 APR 96	KAN	409	594	F
3963427	1F7A2D3604	26 APR 96	KAN	406	758	F
3963427	1F7B677D02	26 APR 96	KAN	410	705	M
3963427	1F7A270937	26 APR 96	KAN	431	786	F
3963427	1F78226F58	26 APR 96	KAN	441	819	F
3963427	1F7B0F2532	26 APR 96	KAN	460	933	F
3963427	1F781F6961	26 APR 96	KAN	466	934	M
3963427	1F782F5367	26 APR 96	KAN	481	1217	M
3963433	7F7A124451	27 APR 96	HAV	249	139	U
3963433	7F7D7F4526	27 APR 96	HAV	266	174	U
3963433	7F7D7F3835	27 APR 96	HAV	276	173	U
3963433	7F7B184B09	27 APR 96	HAV	274	179	U
3963433	7F7B072B07	27 APR 96	HAV	276	198	U
3963433	1F3E6C2C0B	27 APR 96	HAV	272	183	U
3963433	1F7A2D4476	27 APR 96	HAV	282	239	U
3963433	1F3E692911	27 APR 96	HAV	286	233	U

Appendix 17 continued.

Study	PIT Tag Number	Date	Location	Total Length	Weight	Sex
<u>Flannelmouth Sucker continued</u>						
3963433	1F3C271C62	27 APR 96	HAV	281	166	U
3963433	7F7A121A5B	27 APR 96	HAV	281	205	U
3963433	7F7D7F4834	27 APR 96	HAV	298	154	U
3963433	7F7B1A0D16	27 APR 96	HAV	299	270	U
3963433	7F7A136223	27 APR 96	HAV	292	216	U
3963433	1F3C1B3555	27 APR 96	HAV	298	266	U
3963433	7F7B1A0A64	27 APR 96	HAV	296	239	U
3963433	7F7A123D5A	27 APR 96	HAV	293	231	F
3963433	7F7B183255	27 APR 96	HAV	303	250	U
3963433	7F7A138C36	27 APR 96	HAV	304	240	F
3963433	7F7D7F4569	27 APR 96	HAV	310	275	F
3963433	7F7A124F79	27 APR 96	HAV	310	307	F
3963433	7F7B19791A	27 APR 96	HAV	311	317	F
3963433	1F3C207C09	27 APR 96	HAV	318	326	F
3963433	7F7A16543D	27 APR 96	HAV	324	382	F
3963433	7F7A124F1A	27 APR 96	HAV	327	293	U
3963433	7F7B19035E	27 APR 96	HAV	332	322	F
3963433	1F3E664974	27 APR 96	HAV	333	340	U
3963433	1F78001B4E	27 APR 96	HAV	346	359	U
3963433	7F7A123C5C	27 APR 96	HAV	349	383	F
3963433	7F7B1A0930	27 APR 96	HAV	343	456	U
3963433	7F7B1A0022	27 APR 96	HAV	359	423	M
3963433	7F7B197F1D	27 APR 96	HAV	354	368	U
3963433	1F3E6A7148	27 APR 96	HAV	359	416	F
3963433	1F7A3D2E7C	27 APR 96	HAV	369	455	U
3963433	1F7A7B5418	27 APR 96	HAV	372	496	F
3963433	7F7D7F543A	27 APR 96	HAV	386	568	M
3963433	7F7B197D20	27 APR 96	HAV	389	495	F
3963433	7F7B19703C	27 APR 96	HAV	402	533	F
3963433	7F7B070651	27 APR 96	HAV	412	697	M
3963433	7F7B192561	27 APR 96	HAV	425	590	F
3963433	7F7A121831	27 APR 96	HAV	421	603	F
3963433	7F7B19776D	27 APR 96	HAV	426	727	F
3963433	7F7B073D33	27 APR 96	HAV	434	714	U

Appendix 17 continued.

Study	PIT Tag Number	Date	Location	Total Length	Weight	Sex
<u>Flannelmouth Sucker continued</u>						
3963433	7F7B187A4C	27 APR 96	HAV	432	816	F
3963433	7F7D7F3A0E	27 APR 96	HAV	442	776	M
3963433	7F7D444E06	27 APR 96	HAV	459	946	M
3963433	1F7A2D4E6C	27 APR 96	HAV	462	1015	F
3963433	1F7A29330B	27 APR 96	HAV	474	965	M
3963433	1F7A361B16	27 APR 96	HAV	509	1167	M
3964006	1F7A3D1614	20 JUN 96	55.50	279	237	U
3964006	1F78322F08	20 JUN 96	55.50	312	327	U
3964233	1F7A2B5963	25 JUN 96	108.60	315	343	U
3964233	1F7B0B7368	25 JUN 96	108.60	369	512	U
3964233	1F7B074E11	25 JUN 96	108.60	362	591	U
3964233	1F7B681569	25 JUN 96	108.60	386	615	U
3964233	1F780A4916	25 JUN 96	108.60	393	603	U
3964233	1F77744F27	25 JUN 96	108.60	433	933	U
3964459	1F783E3675	25 JUN 96	SHM	330	335	U
3964459	1F780B015D	25 JUN 96	SHM	331	334	U
3964459	1F7B4A405C	25 JUN 96	SHM	358	418	U
3964459	1F7A2F397F	25 JUN 96	SHM	378	598	U
3964459	1F782A704F	25 JUN 96	SHM	389	635	U
3964459	1F7B00372F	25 JUN 96	SHM	390	523	U
3964474	1F5B16313F	27 JUN 96	KAN	244	90	U
3964481	1F7A1C301B	28 JUN 96	HAV	179	46	U
3964481	1F7805392B	28 JUN 96	HAV	181	50	U
3964481	1F78091947	28 JUN 96	HAV	181	47	U
3964481	1F79010463	28 JUN 96	HAV	189	50	U
3964481	1F77715623	28 JUN 96	HAV	182	48	U
3964481	1F78203415	28 JUN 96	HAV	187	554	U
3964481	1F7B0D0C4D	28 JUN 96	HAV	189	51	U
3964481	1F7B492D70	28 JUN 96	HAV	190	55	U
3964481	1F7825467E	28 JUN 96	HAV	190	50	U
3964481	1F77754A2B	28 JUN 96	HAV	193	38	U
3964481	1F7A7A620B	28 JUN 96	HAV	196	66	U
3964481	1F78300039	28 JUN 96	HAV	192	66	U
3964481	1F780F607A	28 JUN 96	HAV	196	66	U

Appendix 17 continued.

Study	PIT Tag Number	Date	Location	Total Length	Weight	Sex
<u>Flannelmouth Sucker continued</u>						
3964481	1F7A2C6C4F	28 JUN 96	HAV	198	55	U
3964481	1F7777660D	28 JUN 96	HAV	194	66	U
3964481	1F783B505E	28 JUN 96	HAV	194	54	U
3964481	1F77703446	28 JUN 96	HAV	196	60	U
3964481	1F5B594E5F	28 JUN 96	HAV	206	68	U
3964481	1F6B43476C	28 JUN 96	HAV	204	58	U
3964481	1F77777300	28 JUN 96	HAV	211	69	U
3964481	1F7A732A4A	28 JUN 96	HAV	210	64	U
3964481	1F7B144A08	28 JUN 96	HAV	211	74	U
3964481	1F781B321C	28 JUN 96	HAV	215	81	U
3964481	1F7A3D2406	28 JUN 96	HAV	221	125	U
3964481	1F5A7F5E2A	28 JUN 96	HAV	221	89	U
3964481	1F7B5B3C4F	28 JUN 96	HAV	236	91	U
3964481	1F7B04263C	28 JUN 96	HAV	231	101	U
3964481	1F7B102036	28 JUN 96	HAV	241	152	U
3964481	1F7B624D37	28 JUN 96	HAV	241	138	U
3964481	1F5E565C51	28 JUN 96	HAV	245	101	U
3964481	1F7A283906	28 JUN 96	HAV	262	148	U
3964481	1F78046D78	28 JUN 96	HAV	261	172	U
3964481	1F7A25083A	28 JUN 96	HAV	278	163	U
3964481	1F7B615C29	28 JUN 96	HAV	279	175	U
3964481	1F7B0F0D4A	28 JUN 96	HAV	271	156	U
3964481	1F782B427C	28 JUN 96	HAV	281	172	U
3964481	1F7B0B5D7E	28 JUN 96	HAV	283	165	U
3964481	1F7B5D4642	28 JUN 96	HAV	308	265	U
3964481	1F78040F56	28 JUN 96	HAV	312	290	U
3964481	1F78252420	28 JUN 96	HAV	319	280	U
3964481	1F77733F38	28 JUN 96	HAV	331	287	U
3964481	1F3E57725A	28 JUN 96	HAV	330	358	U
3964481	7F7B071D15	28 JUN 96	HAV	341	346	U
3964481	1F7A70482F	28 JUN 96	HAV	353	401	U
3964481	7F7D7F3A78	28 JUN 96	HAV	356	398	U
3964481	1F7B5D0207	28 JUN 96	HAV	364	410	U
3964481	1F7A1E3A0F	28 JUN 96	HAV	361	412	U

Appendix 17 continued.

Study	PIT Tag Number	Date	Location	Total Length	Weight	Sex
<u>Flannemouth Sucker continued</u>						
3964481	1F78403970	28 JUN 96	HAV	366	427	U
3964481	1F7B4E6533	28 JUN 96	HAV	378	515	U
3964481	1F78110058	28 JUN 96	HAV	374	518	U
3964481	1F7B080F4F	28 JUN 96	HAV	371	465	U
3964481	1F7A33052F	28 JUN 96	HAV	371	480	U
3964481	7F7B191559	28 JUN 96	HAV	378	571	U
3964481	1F777C1F4F	28 JUN 96	HAV	384	543	U
3964481	1F78796907	28 JUN 96	HAV	384	508	U
3964481	1F78320F28	28 JUN 96	HAV	384	577	U
3964481	1F78193719	28 JUN 96	HAV	394	466	U
3964481	1F78105306	28 JUN 96	HAV	391	574	U
3964481	1F5C152A46	28 JUN 96	HAV	399	725	U
3964481	1F7B560808	28 JUN 96	HAV	393	557	U
3964481	1F78292719	28 JUN 96	HAV	396	571	U
3964481	7F7B073D09	28 JUN 96	HAV	395	585	U
3964481	7F7A124C4E	28 JUN 96	HAV	397	595	U
3964481	1F7A295569	28 JUN 96	HAV	402	526	U
3964481	1F783E7239	28 JUN 96	HAV	406	587	U
3964481	1F7816547F	28 JUN 96	HAV	409	579	U
3964481	1F7B185678	28 JUN 96	HAV	407	789	U
3964481	1F7A376947	28 JUN 96	HAV	401	542	U
3964481	1F6B645042	28 JUN 96	HAV	401	632	U
3964481	1F7B6A106C	28 JUN 96	HAV	407	575	U
3964481	1F7B14034F	28 JUN 96	HAV	408	571	U
3964481	1F7A1D0C3E	28 JUN 96	HAV	418	713	U
3964481	1F7B081945	28 JUN 96	HAV	410	681	U
3964481	1F78387D34	28 JUN 96	HAV	423	642	U
3964481	1F7A1D4307	28 JUN 96	HAV	424	771	U
3964481	1F7A227C49	28 JUN 96	HAV	426	669	U
3964481	1F7772294F	28 JUN 96	HAV	427	772	U
3964481	1F7A7D2842	28 JUN 96	HAV	438	913	U
3964481	1F78043035	28 JUN 96	HAV	434	738	U
3964481	1F7A737C78	28 JUN 96	HAV	445	951	U
3964481	1F7A270B35	28 JUN 96	HAV	446	771	U

Appendix 17 continued.

Study	PIT Tag Number	Date	Location	Total Length	Weight	Sex
<u>Flannemouth Sucker continued</u>						
3964481	1F7A1E4009	28 JUN 96	HAV	441	846	U
3964481	1F781E606B	28 JUN 96	HAV	443	794	U
3964481	1F7B06637D	28 JUN 96	HAV	479	1008	U
3964481	1F78205A6F	28 JUN 96	HAV	476	1011	U
3964481	1F7B4F1601	28 JUN 96	HAV	474	1160	U
3964481	1F7B120450	28 JUN 96	HAV	499	1333	U
3965025	1F7812686F	13 SEP 96	69.48	211	91	U
3965026	1F69342E16	15 SEP 96	111.90	205	115	U
3965026	1F7A77650B	15 SEP 96	111.90	389	601	U
3965030	1F7A334D67	15 SEP 96	122.02	267	195	U
3965030	1F7B614B3A	15 SEP 96	122.02	307	307	U
3965031	1F7B5C2763	15 SEP 96	122.55	370	520	U
3965038	1F78001455	18 SEP 96	165.00	205	9	U
3965038	1F7B58405E	18 SEP 96	165.00	203	85	U
3965038	1F7B601076	18 SEP 96	165.00	215	98	U
3965038	1F7B582668	18 SEP 96	165.00	230	108	U
3965038	1F7B5B7D0E	18 SEP 96	165.00	233	112	U
3965201	1F7B48326C	8 SEP 96	31.00	575	1806	F
3965203	1F7A2A2E3F	8 SEP 96	30.69	395	690	U
3965203	1F2A3A5558	8 SEP 96	30.69	425	766	U
3965203	1F7B49130A	8 SEP 96	30.69	430	805	U
3965203	1F7A2E0F2A	8 SEP 96	30.69	540	1885	F
3965210	1F7B5A4547	10 SEP 96	62.50	409	749	M
3965212	1F7B011E47	10 SEP 96	63.10	452	922	M
3965228	1F7B0A4E0E	14 SEP 96	108.20	325	375	U
3965469	1F77776F04	14 SEP 96	SHM	358	423	F
3965480	1F7A1D0B3F	16 SEP 96	KAN	219	198	U
3965486	7F7A12525E	17 SEP 96	HAV	235	110	U
3965486	1F7A260839	17 SEP 96	HAV	358	445	U
3965486	1F7833575F	17 SEP 96	HAV	365	415	U
3965486	1F7B5E3E4A	17 SEP 96	HAV	371	472	U
3965486	1F7B543B57	17 SEP 96	HAV	383	440	U
3965486	1F7825665E	17 SEP 96	HAV	397	831	U
3965486	1F7B54167C	17 SEP 96	HAV	395	518	U

Appendix 17 continued.

Study	PIT Tag Number	Date	Location	Total Length	Weight	Sex
<u>Flannelmouth Sucker continued</u>						
3965486	1F7A3A7D30	17 SEP 96	HAV	390	570	U
3965486	1F7B5E5335	17 SEP 96	HAV	411	753	U
3965486	1F7A331420	17 SEP 96	HAV	417	740	U
3965486	1F782D1A22	17 SEP 96	HAV	421	748	U
3961001	1F7A3C7338	28 FEB 96	30.73	417	767	M
3961001	1F7A3C7338	28 FEB 96	30.73	417	767	M
3965486	1F7B457829	17 SEP 96	HAV	423	705	U
3965486	1F7A74185B	17 SEP 96	HAV	430	799	U
3965486	1F7A28724D	17 SEP 96	HAV	432	743	U
3965486	1F782B407E	17 SEP 96	HAV	434	734	U
3965486	1F7B541002	17 SEP 96	HAV	442	833	U
3965486	1F7B496439	17 SEP 96	HAV	442	724	U
3965486	1F78414068	17 SEP 96	HAV	456	909	U
3965486	1F7809550B	17 SEP 96	HAV	451	788	U
3965486	1F7A28132C	17 SEP 96	HAV	450	922	U
3965486	1F7B0F3324	17 SEP 96	HAV	465	953	U
3965486	1F7A296658	17 SEP 96	HAV	475	1080	U
3965486	1F78435F47	17 SEP 96	HAV	490	1168	U
<u>Humpback Chub</u>						
3961028	1F7A377B35	1 MAR 96	61.50	425	759	F
3961028	1F7B552F62	1 MAR 96	61.50	384	516	F
3963024	1F7A25675B	19 APR 96	65.18	351	407	F
3963062	1F7B5C6921	21 APR 96	60.85	326	278	M
3963067	7F7D7F3F4F	21 APR 96	63.50	185	62	U
3964218	1F7A7C3338	22 JUN 96	64.65	150	33.2	U
3964481	1F7B091A43	28 JUN 96	HAV	211	104	M
3965018	1F7A74294A	11 SEP 96	65.25	150	30.8	U
3965018	7F7B1A0C4D	11 SEP 96	65.25	163	39.2	U
3965023	1F7B190449	12 SEP 96	68.39	164	66	U
3965023	1F7A29447A	12 SEP 96	68.39	166	38	U
3965023	1F7A215076	12 SEP 96	68.39	184	62	U
3965023	1F77725820	12 SEP 96	68.39	180	53	U
3965023	1F7A356F43	12 SEP 96	68.39	186	63	U
3965023	1F7B503F57	12 SEP 96	68.39	199	69	U

Appendix 17 continued.

Study	PIT Tag Number	Date	Location	Total Length	Weight	Sex
<u>Humpback Chub continued</u>						
3965023	1F77745323	12 SEP 96	68.39	206	92	U
3965029	1F7903667F	15 SEP 96	119.54	154	33.4	U
3965030	1F7A7D3D2D	15 SEP 96	122.02	181	64	F
3965030	1F7B4B001B	15 SEP 96	122.02	233	131	F
3965203	1F781E7F4C	8 SEP 96	30.69	445	955	F
3965208	1F78395B55	9 SEP 96	60.71	269	205	F
3965208	1F7B6E3C3C	9 SEP 96	60.71	370	485	M
3965214	1F7B56216F	11 SEP 96	64.63	349	420	M
3965218	1F7837151D	12 SEP 96	68.42	387	522	M
3965486	1F7818470A	17 SEP 96	HAV	383	710	U

Appendix 18. PIT tag number and total length (mm), weight (g), sex, and location (river mile or tributary) and date of present and previous capture of all fish previously implanted (recaptures) with a PIT tag in the Colorado River and tributaries, Grand Canyon, Arizona, during AGFD Monitoring trips, 1996.

Study	PIT tag Number	Date	Present Capture			Sex	Date	Previous Capture			Mark/ Recap.
			Total Length	Weight	Location			Total Length	Weight	Location	
Flannelmouth Sucker											
3961002	7F7D1E1A30	28 FEB 96	30.75	391	592	U	28 MAY 93	192.4	163	41	M
3961027	1F7A7E4C1D	1 MAR 96	61.53	439	887	U	8 NOV 94	LCR	397	622	M
3961028	7F7D49012D	1 MAR 96	61.5	435	727	M	18 MAY 93	LCR	190	49	M
3961028	7F7F157940	1 MAR 96	61.5	429	764	U	16 APR 94	143.5	309	283	M
3961028	7F7F267E08	1 MAR 96	61.5	431	681	U	17 MAY 93	LCR	179	40	M
3961028	7F7A1A4B43	1 MAR 96	61.5	497	1223	M					
3961028	7F7B072B0C	1 MAR 96	61.5	446	897	U	11 MAY 94	LCR	272	154	M
3961028	1F7B063E22	1 MAR 96	61.5	452	866	M					
3961028	7F7B1B232B	1 MAR 96	61.5	386	562	U	17 APR 94	156.93	263	174	M
3961028	1F45F3745B	1 MAR 96	61.5	373	536	U					
3961028	7F7F477F5C	1 MAR 96	61.5	534	1692	U					
3961028	1F3E6B793F	1 MAR 96	61.5	405	650	U	17 AUG 94	LCR	305		M
3961028	1F3E631F21	1 MAR 96	61.5	408	687	M	7 JUL 94	108.6	307	259	M
3961028	7F7F32304A	1 MAR 96	61.5	500	1249	M	10 DEC 91	LCR	507	1488	M
3961028	1F0F636E01	1 MAR 96	61.5	540	1675	F	16 JUL 93	LCR	515	1354	M
3961047	7F7A136C71	2 MAR 96	61.5	404		M	8 NOV 94	LCR	267	142	M
3961047	7F7B1A4845	2 MAR 96	61.5	443	811	M	16 APR 94	143.5	315	285	M
3961075	7F7F27226D	3 MAR 96	68.36	582	2050	M	23 MAR 93	LCR	565	1862	M
3961134	7F7D1D0E45	8 MAR 96	HAV	392	580	U	23 APR 93	191.42	157	39	M
3961134	7F7D177255	8 MAR 96	HAV	500	1230	M	21 SEP 91	LCR	507	1800	M
3961134	1F20303E53	29 APR 96	HAV	328	369	F	8 MAR 96	HAV	320	356	R

Appendix 18 continued.

Study	PIT tag Number	Date	Location	Present Capture		Sex	Date	Previous Capture		Mark/ Recap.
				Total Length	Weight			Total Length	Weight	
Elannemouth Sucker continued										
3961134	7F7D445A3C	8 MAR 96	HAV	445	893	M	8 APR 95	156.93	416	640 M
3961134	7F7F33457A	8 MAR 96	HAV	430	854	M				
3961134	1F7B18A134	8 MAR 96	HAV	340	372	U				
3961134	7F7D026B31	8 MAR 96	HAV	560	2069	U				
3961134	7F7F213239	8 MAR 96	HAV	521	1320	U				
3962131	1F7B6A700C	30 MAR 96	188.1	181	54	U	30 MAR 96	188.2	181	54 M
3962131	1F7A305C5B	30 MAR 96	188.1	199	95	U	30 MAR 96	188.2	199	95 M
3963053	1F78004524	20 APR 96	62.25	405	652	U				
3963061	7F7D180C08	21 APR 96	61.15	346	463	U	27 APR 94	180	162	40 M
3963063	7F7D2A4C3D	21 APR 96	60.83	517	1337	U	15 AUG 91	LCR	464	985 M
3963063	7F7D1B6C1A	21 APR 96	60.83	490	946	U	26 JUL 91	180	295	220 M
3963063	7F7F261301	21 APR 96	60.83	504	1423	M	9 NOV 91	LCR	505	1138 M
3963204	1F78251430	22 APR 96	68.07	443	1007	M	2 MAR 96	61.5	451	1044 M
3963427	1F0C794B11	29 APR 96	KAN	254	155	U	7 APR 95	143.1	205	84 M
3963427	1F7B63592A	29 APR 96	KAN	299	258	U				
3963427	7F7B187769	29 APR 96	KAN	409	711	F	12 JAN 95	LCR	348	428 M
3963427	7F7B1A062C	29 APR 96	KAN	374	526	M	9 JUL 94	143.5	290	237 M
3963427	7F7F217765	29 APR 96	KAN	395	649	U				
3963427	1F7A347142	29 APR 96	KAN	245	148	U				
3963427	1F78347045	29 APR 96	KAN	330	375	F	9 NOV 94	LCR	228	78 M
3963427	1F7774284E	29 APR 96	KAN	327	343	F				
3963427	7F7F284C7C	29 APR 96	KAN	478	918	M				
3963427	1F7B12666E	29 APR 96	KAN	268	176	F	23 JUN 95	143.5	347	413 M

Appendix 18 continued.

Present Capture							Previous Capture				
Study	PIT tag Number	Date	Location	Total	Weight	Sex	Date	Location	Total	Weight	Mark/ Recap.
				Length					Length		
Elannelmouth Sucker continued											
3963427	1F7B126B69	29 APR 96	KAN	329	344	F	2 MAR 96	61.5	404		R
3963427	1F2E546E61	29 APR 96	KAN	285	256	F	8 MAR 96	HAV	326	323	M
3963427	1F3C18434A	29 APR 96	KAN	273	208	F	7 APR 95	143.5	221	115	M
3963433	1F7B4A7B21	27 APR 96	HAV	431	735	F	24 JUN 95	156.93	424	718	M
3963433	7F7F287F5C	27 APR 96	HAV	494	1174	M					
3963433	1F78241E27	27 APR 96	HAV	249	136	U	25 SEP 95	143	239	115	M
3963433	7F7D090F62	27 APR 96	HAV	521	1375	M					
3963433	7F7F1F125B	27 APR 96	HAV	424	693	M					
3963433	1F0C760659	27 APR 96	HAV	440	1063	F					
3964108	1F7B631073	21 JUN 96	62.48	360	430	U					
3964233	7F7B02072E	25 JUN 96	108.6	431	810	U	28 MAY 94	143.5	343	381	R
3964459	7F7F1F1C66	25 JUN 96	SHM	414	804	U					
3964459	177A3A2A03	25 JUN 96	SHM	400	640	U					
3964459	7F7B0E2603	25 JUN 96	SHM	392	752	U	21 MAR 93	120.47	165	49	M
3964481	1F783D2C00	28 JUN 96	HAV	381	490	U					
3964481	1F7A242D16	28 JUN 96	HAV	410	622	U	8 APR 95	LCR	339	400	M
3964481	1F78410F19	28 JUN 96	HAV	403	592	U					
3964481	1F78232B1B	28 JUN 96	HAV	349	401	U					
3964481	1F707D7C6D	28 JUN 96	HAV	471	1077	U					
3964481	1F3E646758	28 JUN 96	HAV	394	535	U					
3964481	1F78156A6A	28 JUN 96	HAV	396	562	U					
3964481	1F77751362	28 JUN 96	HAV	209	78	U	24 APR 96	87.45	196	60	M

Appendix 18 continued.

Study	PIT tag Number	Date	Present Capture			Previous Capture				Mark/ Recap.
			Location	Length	Weight	Sex	Date	Location	Length	
Flannelmouth Sucker continued										
3964481	1F7B3D0F1D	28 JUN 96	HAV	348	383	U				
3964481	7F7A136867	28 JUN 96	HAV	354	430	U				
3964481	7F7F334B09	28 JUN 96	HAV	531	1380	U				
3964481	1F7A3A2A03	28 JUN 96	HAV	401	681	U				
3964481	7F7B0D6125	28 JUN 96	HAV	426	742	U	28 MAY 93	192.4	88	67 M
3964481	1F7A3A3875	28 JUN 96	HAV	369	463	F	29 APR 96	183	356	464 M
3965202	7F7B07372D	8 SEP 96	30.7	455	1043	U	20 APR 94	80	404	656 M
3965202	1F7B52266E	8 SEP 96	30.7	530	1690	U				
3965223	1F777C3D31	13 SEP 96	75.04	438	974	M				
3965486	1F204E690A	17 SEP 96	HAV	339	316	U	11 JUN 95	30	216	85 M
3965486	7F7B0D7A29	17 SEP 96	HAV	462	921	U	7 MAY 93	LCR	186	44 R
							14 MAR 93	61.5	172	37 M
3965486	7F7A141315	17 SEP 96	HAV	426	988	U	9 NOV 94	LCR	258	M
3965486	1F7A326C49	17 SEP 96	HAV	393	984	U				
Humpback Chub										
3961001	1F200B5462	28 FEB 96	30.73	460	1141	U				
3961002	7F7D08013E	28 FEB 96	30.75	451	852	F	11 APR 93	30.5	446	868 M
3961010	7F7F276D65	29 FEB 96	64.55	394	507	M	16 FEB 93	LCR	388	528 M
3961010	7F7F3C4518	29 FEB 96	64.55	334	411	M	12 MAY 95	LCR	338	R
							20 MAR 93	63.3	327	387 R
							14 SEP 91	64.7	325	378 M
3961027	7F7D2B5760	1 MAR 96	61.53	380	428	F	26 JUL 91	LCR	375	M
3961028	7F7B18205F	1 MAR 96	61.5	342	402	M				

Appendix 18 continued.

Study	PIT tag Number	Date	Present Capture			Previous Capture						
			Location	Total Length	Weight	Sex	Date	Location	Total Length	Weight	Mark/ Recap.	
Humpback Chub continued												
3961028	7F7D181173	1 MAR 96	61.5	399	532	F	10 SEP 92	58.3	385	239	R	
							10 JUN 91	LCR	400	452	M	
3961028	7F7F1F0D21	1 MAR 96	61.5	395	475	F	16 FEB 93	LCR	390	444	M	
3961028	7F7D2B147F	1 MAR 96	61.5	375	416	F	18 JUL 94	65.3	378	391	R	
							28 APR 92	LCR	356	318	M	
3961028	7F7F396046	1 MAR 96	61.5	405	547	F	18 JAN 93	63.3	408	668	R	
							6 MAR 92	LCR	405	564	M	
3961031	7F7F3E317C	1 MAR 96	60.85	325	315	M	22 NOV 90	65.5	303	257	M	
3961031	7F7F33292F	1 MAR 96	60.85	336	383	F	3 NOV 92	60.5	309	302	M	
3961031	7F7F18382D	1 MAR 96	60.85	345	474	F	18 APR 93	LCR	348	390	M	
3961031	7F7F1F0E49	1 MAR 96	60.85	314	286	M	15 SEP 91	LCR	306	188	M	
3961031	1F465F436E	1 MAR 96	60.85	370	393	M						
3961047	7F7D31706D	2 MAR 96	61.5	391	622	F	28 APR 92	LCR	377	358	M	
3961049	7F7D154102	2 MAR 96	60.85	348	441	F	12 MAY 93	LCR	345	363	R	
							30 MAR 91	LCR	320	315	M	
3961049	7F7F2C1314	2 MAR 96	60.85	368	576	F	21 MAY 92	LCR	360	378	M	
3961049	7F7D02652D	2 MAR 96	60.85	380	496	M	14 JUN 91	58.4	368	448	M	
3961049	7F7F32384A	2 MAR 96	60.85	335	373	F						
3961049	7F7F3333715	2 MAR 96	60.85	398	592	M	15 SEP 92	61.3	396	624	M	
3963004	1F1F70537F	18 APR 96	30.69	395	701	F	13 JUN 95	30.6	395	607	R	
3963025	7F7F276360	19 APR 96	64.52	399	776	F	16 NOV 92	LCR	407	600	M	
3963025	7F7F1F112E	19 APR 96	64.52	320	324	F	21 MAR 93	64.6	320	318	M	
3963025	7F7F39072D	19 APR 96	64.52	453	846	F	20 MAY 92	LCR	482	844	M	

Appendix 18 continued.

Study	PIT tag Number	Date	Present Capture			Previous Capture			Mark/ Recap.		
			Total Length	Weight	Sex	Date	Total Length	Weight			
Humpback Chub continued											
3963025	7F7D3F7E09	19 APR 96	64.52	371	468	U	19 APR 96	64.52	365	464	R
							8 SEP 93	65.25	368		R
							4 APR 93	LCR	370	378	M
3963025	7F7E2A6B3F	19 APR 96	64.52	429	779	F	17 MAY 93	LCR	425	628	M
3963025	1F78233016	19 APR 96	64.52	364	499	F					
3963025	7F7E431A67	19 APR 96	64.52	366	440	M	14 NOV 92	LCR	378	422	M
3963025	7F7F394669	19 APR 96	64.52	344	428	F	25 APR 92	LCR	341	410	M
3963025	1F7B513F56	19 APR 96	64.52	379	674	F					
3963025	7F7F450369	19 APR 96	64.52	394	483	M	18 JUL 92	65.2	382	500	R
							14 SEP 91	64.7	391	456	R
							21 NOV 90	65.5	368	604	R
3963026	7F7F3F4802	19 APR 96	64.3	376	625	F					
3963026	7F7B19747F	19 APR 96	64.3	348	409	F					
3963047	7F7D481D09	20 APR 96	63.05	275	175	U	18 MAY 93	LCR	250	128	M
3963061	7F7D225614	21 APR 96	61.15	370	525	F	2 AUG 91	LCR	370	500	M
3963061	7F7F3E272F	21 APR 96	61.15	375	479	F	18 JUL 91	62.2	350	435	M
3963063	1F0C712B39	21 APR 96	60.83	275	169	F	14 JUN 93	LCR	216	60	R
							12 JUN 93	LCR	215	48	M
3963063	7F7D170B15	21 APR 96	60.83	292	214	F	8 JUL 91	LCR	216	63	M
3963063	7F7B1A0140	21 APR 96	60.83	367	533	M					
3963063	7F7F480A30	21 APR 96	60.83	332	369	F	6 NOV 92	60.9	335	335	M
3963063	7F7F7E5C68	21 APR 96	60.83	387	477	F	26 APR 92	LCR	380	508	M
3963063	7F7D2C3624	21 APR 96	60.83	283	230	F	12 DEC 91	LCR	150	34	M
3963063	1F7A7C6B00	21 APR 96	60.83	276	216	U					

Appendix 18 continued.

Study	PIT tag Number	Date	Present Capture			Previous Capture				Mark/ Recap.	
			Total Length	Weight	Sex	Date	Total Length	Weight	Recap.		
Humpback Chub continued											
3963063	7F7D18171B	21 APR 96	60.83	245	170	F	3 JUN 91	LCR	173	44	M
3963063	7F7D305007	21 APR 96	60.83	383	517	F	16 JAN 93	60.4	382	591	R
							15 JAN 93	60.4	394	598	R
							8 MAR 92	LCR	382	546	M
3963203	7F7F3C6C75	22 APR 96	68.07	412	588	M	23 APR 90	LCR	403	536	M
3963303	1F781D311B	22 APR 96	67.58	300	246	U					
3964105	7F7F33057E	20 JUN 96	61.26	351	434	F	28 MAY 92	LCR	344	390	M
3964106	7F7F044465	20 JUN 96	60.85	406	617	F	16 MAY 89	LCR	380	257	M
3964106	7F7D175211	20 JUN 96	60.85	305	218	M	7 JUL 91	LCR	183		M
3964112	1F46741C0B	22 JUN 96	63.29	395	632	F					
3964206	7F7D174775	20 JUN 96	62.1	327	270	U	7 JUL 91	LCR	293	185	M
3965029	1F78426344	15 SEP 96	119.54	154	33.4	U					
3965030	7F7F1F1346	15 SEP 96	122.02	315	315	M	13 JUL 92	92.2	272	229	M
3965201	7F7F2C301B	8 SEP 96	30.7	375	497	M	15 SEP 95	30.8	372	438	R
							30 MAR 92	LCR	458	384	M
3965202	1F1E4A3148	8 SEP 96	30.7	415	656	F					
3965207	7F7D2B1E43	9 SEP 96	60.85	415	526	M	23 JUN 92	LCR	404	453	R
							25 JUL 91	LCR	403		M
3965208	7F7D177C45	9 SEP 96	60.71	370	458	M	13 JUN 91	LCR	360	346	M
3965208	7F7D177840	9 SEP 96	60.71	355	399	F	15 AUG 91	LCR	155	28	M
3965209	7F7F2D5305	10 SEP 96	62.4	361	427	F	28 MAR 92	LCR	348	346	M
3965209	1F2F374C2F	10 SEP 96	62.4	280	177	M	16 AUG 93	LCR	220	58	M
3965211	7F7A167126	10 SEP 96	62.6	381	494	M	12 APR 95	LCR	381	76	R

Appendix 18 continued.

Study	PIT tag Number	Date	Present Capture			Previous Capture			Mark/ Recap.		
			Location	Total Length	Weight	Sex	Date	Location		Total Length	Weight
Humpback Chub continued											
3965212	7F7E2C111F	10 SEP 96	63.1	364	485	F	22 MAY 92	LCR	343	282	M
3965214	7F7D18082F	1 MAR 96	61.5	353	444	U	11 SEP 96	64.63	325	358	R
3965214	1F1F65015C	11 SEP 96	64.63	241	200	F	12 JUN 94	LCR	221	73	R
							14 MAY 94	LCR	222	72	R
							15 AUG 93	LCR	197	58	R
							15 AUG 93	LCR	198	59	M
3965214	7F7D180E2B	11 SEP 96	64.63	375	460	M					
3965216	7F7D2B3673	11 SEP 96	64.4	378	676	F	10 MAR 92	LCR	364	540	M
3965216	7F7F445D54	11 SEP 96	64.4	376	505	M	27 APR 93	LCR	361	402	R
3965218	1F78400B1E	12 SEP 96	68.42	401	680	F					
3965218	7F7D177D40	12 SEP 96	68.42	400	650	F	17 JUN 91	LCR	343	332	M
3965220	7F7D294527	12 SEP 96	68.06	429	850	F	10 JAN 92	LCR	415	694	M
Rainbow Trout											
3963025	CWT	19 APR 96	64.52	335	352	U		Lee's Ferry			M

Appendix 19. Personnel participating in each AGFD Monitoring trip, 1996.

Personnel	Agency	Duties	Comments
<u>Trip 96-1: 28 February - 14 March 1996</u>			
Tim Hoffnagle	AGFD	Biologist/Trip Leader	
Mark Brouder	AGFD	Biologist/Co-Trip Leader	continued on to Pearce Ferry with HDNR- out 20 March
Tom Dresser	AGFD	Biologist	continued on to Pearce Ferry with HDNR - out 20 March
Scott Rogers	AGFD	Biologist	
Rich Valdez	Bio/West	Biologist	out LCR; 3 March)
Brian Cowdell	Bio/West	Biologist	out LCR (3 March)
Helen Yard	Bio/West	Biologist	out LCR (3 March)
Pete Cavalli	Utah DNR	Biologist/Volunteer	out Diamond Creek (11 March)
Albert Sillas	USFS	Biologist/Volunteer	out Diamond Creek (11 March)
Bob Broscheid	AGFD	Biologist/Volunteer	in Phantom (5 March), out Diamond Creek (11 March)
Melissa Kreighbaum	AGFD	Biologist/Volunteer	in Phantom (5 March), out Diamond Creek (11 March)
Dan Gaska	AGFD	Biologist/Volunteer	in Phantom (5 March), out Diamond Creek (11 March)
John Nagy	GCES	Surveyor	joined trip at Lava Chuar (3 March), out Havasu Creek (9 March)
Greg Williams	OARS	Boatman	
Tony Anderson	OARS	Boatman	
Chris Geanious	OARS	Boatman	
Bruce Helin	OARS	Boatman	out at Diamond Creek (11 March)
Matt Herman	OARS	Boatman	in at Tanner (4 March)
<u>Trip 96-3: 18 April - 3 May 1996</u>			
Tim Hoffnagle	AGFD	Biologist/Trip Leader	

Appendix 19 continued.

Personnel	Agency	Duties	Comments
<u>Trip 96-3 continued</u>			
Mark Brouder	AGFD	Biologist/Co-Trip Leader	
Tom Dresser	AGFD	Biologist	hiked out Havasu Creek (28 April)
Michael Douglas	ASU	Biologist	
Marlis Douglas	ASU	Biologist	
Todd Hanna	WGFD	Biologist/Volunteer	
Wes Shoop	AGFD	Biologist/Volunteer	hiked out Havasu Creek (28 April)
Tom Fresques	AGFD	Biologist/Volunteer	hiked out Havasu Creek (28 April)
Dave Speas	SDSU	Biologist/Volunteer	hiked out Havasu Creek (28 April)
Peter Mui	GCES	Surveyor/Volunteer	
Chris Brod	GCES	Surveyor	
Greg Williams	OARS	Boatman	
Stuart Reeder	OARS	Boatman	
Tony Anderson	OARS	Boatman	
Steve Bledsoe	OARS	Boatman	
<u>Trip 96-4: 19 June - 4 July 1996</u>			
Tim Hoffnagle	AGFD	Biologist/Trip Leader	
Mark Brouder	AGFD	Biologist/Co-Trip Leader	
Tom Dresser	AGFD	Biologist	hiked out Havasu Creek (29 June)
Dave Speas	AGFD	Biologist	
Michael Douglas	ASU	Biologist	
Marlis Douglas	ASU	Biologist	
Rebecca Cole	USGS - BRD	Biologist	
Bruce Michael	AGFD	Biologist/Volunteer	hiked out Havasu Creek (29 June)

Appendix 19 continued.

Personnel	Agency	Duties	Comments
<u>Trip 96-4 continued</u>			
Rick Cordes	SDDGFP	Biologist/Volunteer	hiked out Havasu Creek (29 June)
Michele Thieme	UA	Biologist	hiked out Havasu Creek (29 June)
Lanie Johnstone	GCES	Biologist	dropped off at Kwagunt (20 June)
Greg Williams	OARS	Boatman	
Duffy McCabe	OARS	Boatman	
Larry Bluth	OARS	Boatman	
John Helmer	OARS	Boatman	
Pauly Mann	OARS	Swamper	
Leann Huff	OARS	Swamper	out Phantom (25 June)
Scott Crozier	HDNR	Swamper	
Suzie Thomas	OARS	Swamper	in Phantom (25 June)
<u>Trip 96-5: 8 - 23 September 1996</u>			
Tim Hoffnagle	AGFD	Biologist/Trip Leader	hiked out Havasu Creek (18 September)
Mark Brouder	AGFD	Biologist/Co-Trip Leader	
Tom Dresser	AGFD	Biologist	
Dave Speas	AGFD	Biologist	
Marty Tuegel	AGFD	Biologist	out Phantom (14 September)
Bill Persons	AGFD	Biologist	in Phantom (14 September)
Michael Douglas	ASU	Biologist	
Marlis Douglas	ASU	Biologist	
Roy Whaley	WGFD	Biologist/Volunteer	hiked out Havasu Creek (18 September)
Al Geddings	WGFD	Biologist/Volunteer	hiked out Havasu Creek (18 September)
Greg Williams	OARS	Boatman	

Appendix 19 continued.

Personnel	Agency	Duties	Comments
<u>Trip 96-5 continued</u>			
Duffy McCabe	OARS	Boatman	
Lars Niemi	OARS	Boatman	
Tony Anderson	OARS	Boatman	out Phantom (14 September)
Jimmy Grissom	OARS	Boatman	in Phantom (14 September)
Mike Vaughn	HDNR	Swamper	

Appendix 20. Locations of campsites used during each AGFD Monitoring trip, 1996.

Trip/Date	Campsite	Location
<u>Trip 96-1</u>		
28 February	South Canyon	30.29 R
29 February	Lava Chuar	65.5 R
1 March	Lava Chuar	65.5 R
2 March	Lava Chuar	65.5 R
3 March	Tanner	68.39 R
4 March	Upper Rattlesnake	74.4 R
5 March	Bass	108.20 R
6 March	Randy's Rock	126.37 R
7 March	Kanab Creek	143.31 L
8 March	Last Chance (above Havasu)	155.6 R
9 March	National Canyon	166.5 L
10 March	RM 183	182.8 R
11 March	RM 194	194.1 L
12 March	Granite Park	208.8 L
13 March	above Diamond Creek	224.00 L
14 March	Take out at Diamond Creek	225.5 L
<u>Trip 96-3</u>		
18 April	South Canyon	30.29 R
19 April	Carbon Creek	64.55 R
20 April	Carbon Creek	64.55 R
21 April	Carbon Creek	64.55 R
22 April	Tanner	68.39 R
23 April	Upper Rattlesnake	74.4 R
24 April	Upper Bass	107.90 R
25 April	Randy's Rock	126.37 R
26 April	Kanab Creek	143.31 L
27 April	Above Havasu	156.5 R
28 April	Stairway	171.1 R
29 April	RM 183	183.0 L
30 April	RM 183	183.0 L
1 May	Granite Park	208.8 L

Appendix 20 continued.

<u>Trip/Date</u>	<u>Campsite</u>	<u>Location</u>
<u>Trip 96-3 continued</u>		
2 May	Diamond Creek	225.5 L
3 May	Take out at Diamond Creek	225.5 L
<u>Trip 96-4</u>		
19 June	South Canyon	30.29 R
20 June	Carbon Creek	64.55 R
21 June	Carbon Creek	64.55 R
22 June	Carbon Creek	64.55 R
23 June	Tanner	68.39 R
24 June	Upper Rattlesnake	74.4 R
25 June	Upper Bass	107.90 R
26 June	Randy's Rock	126.37 R
27 June	Kanab Creek	143.31 L
28 June	Last Chance (above Havasu)	156.5 R
29 June	Stairway	171.1 R
30 June	RM 183	183.0 L
1 July	RM 183	183.0 L
2 July	Granite Park	208.8 L
3 July	above Diamond Creek	224.00 L
4 July	Take out at Diamond Creek	225.5 L
<u>Trip 96-5</u>		
8 September	South Canyon	30.29 R
9 September	Carbon Creek	64.55 R
10 September	Carbon Creek	64.55 R
11 September	Carbon Creek	64.55 R
12 September	Tanner	68.39 R
13 September	Upper Rattlesnake	74.4 R
14 September	Upper Bass	107.90 R
15 September	Randy's Rock	126.37 R
16 September	Kanab Creek	143.31 L
17 September	Last Chance (above Havasu)	156.5 R
18 September	Stairway	171.1 R

Appendix 20 continued.

<u>Trip/Date</u>	<u>Campsite</u>	<u>Location</u>
<u>Trip 96-5 continued</u>		
19 September	RM 183	183.0 L
20 September	RM 183	183.0 L
21 September	Granite Park	208.8 L
22 September	above Diamond Creek	224.00 L
23 September	Take out at Diamond Creek	225.5 L